

Understanding scepticism in times of a pandemic

A study towards the antecedents of COVID-19 scepticism

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Abstract

This study investigated the antecedents of COVID-19 scepticism. In order to decide on possible determinants, it was tested whether one, or multiple, antecedents of scepticism towards climate change, vaccinations and GMO's related to COVID-19 scepticism as well. For this study, data from an online survey on political ideology, scientific trust, anxieties, and knowledge related to COVID-19 was used. Findings showed that important antecedents of COVID-19 scepticism were COVID-19 related knowledge and age. In addition, the effect of COVID-19 related knowledge on COVID-19 scepticism was especially strong for young participants. Based on these findings, it is concluded that COVID-19 scepticism relates most to GMO scepticism. However, as this study only analysed data on the first wave of the corona pandemic, future studies are needed to test the generalizability of these findings for later waves of the pandemic.

Problem statement

Having the ability to think about, and analyse the world around us can be seen as an important human quality. It can force us to think critically, protect us against false assumptions and ideas, and stimulate the progression of knowledge and science. However, what happens when the ability to think critically turns into scepticism towards commonly accepted knowledge, or scientific consensus? While scepticism towards accepted knowledge and science has always existed, the current COVID-19 global health crisis has clearly illustrated the impact that widespread science scepticism can have on societies. For example, in the U.S. the government struggles to achieve sufficient compliance with social distancing measures, because some people actively deny the virus to be dangerous. Furthermore, there is an increasing number of people who do not believe COVID-19 exists at all, and advocate aggression and disobedience (BBC, 2020). In the context of COVID-19, science scepticism becomes a dangerous phenomenon that not only endangers the sceptic individual, but their direct and indirect environments as well. Mainly because COVID-19 sceptics are less likely to adhere to social distancing guidelines (Plohl and Musil, 2020).

COVID-19 is a recent phenomenon and the literature base reflects that. As of now, relative little is known about the antecedents of scepticism towards COVID-19 specifically. Earlier research into scepticism mainly focuses on scepticism within three controversial scientific topics, namely: climate change, vaccinations and genetically modified organisms (GMO's) (Rutjens et al, 2017). Interestingly, scepticism towards these various scientific

topics stems from differing antecedents. In general, scepticism towards climate change is related to political conservatism, vaccination scepticism is associated with trust in institutions, and finally, scepticism towards GMO's stems from a lack of domain specific knowledge (Drummond and Fischhoff, 2017; Pechar et al, 2018; Rutjens et al, 2017). Whether one, or several, of these antecedents play a role in COVID-19 scepticism remains to be seen. This paper builds on prior literature by exploring whether one, or multiple, underlying mechanisms related to climate change, vaccination and GMO's evoke COVID-19 scepticism as well. Extending the current literature base with COVID-19, could provide practical implications for possible interventions to increase COVID-19 guideline compliance.

Existing research

COVID-19

According to the WHO (2020), COVID-19 is an infectious respiratory disease caused by a newly discovered coronavirus. The most common symptoms of the virus include a fever in combination with a cough. Most infected people experience mild to moderate symptoms (WHO, 2020). Within a couple of months, COVID-19 spread across almost the entire world. In the U.S. alone, the coronavirus has caused 607.704 deaths (The New York Times, 2021). To defend vulnerable people – such as the elderly and individuals with underlying health conditions – governments had to take radical preventive measures such as lockdowns and social distancing campaigns. Initially, these measures were met with widespread support. However, at this time, due to growing scepticism towards COVID-19, an increasing number of individuals refuse to adhere to social distancing measures (Plohl and Musil, 2020). This is dangerous, because it could expose vulnerable people to further health risks.

Scepticism

So, what is science scepticism and more specifically, how should scepticism towards COVID-19 be understood? In short, science scepticism refers to a systematic and unwarranted rejection of scientific facts. (Rutjens et al, 2021). Within the topic of COVID-19, such rejections could range from downplaying symptoms, to underestimating the infectiousness, to complete denial of the existence of the virus. Because COVID-19 is a recent phenomenon, insight in which factors are most likely to cause scepticism is lacking. To form an idea about factors that could play a role, it is important to first look at existing literature towards science scepticism, within already studied scientific topics. These thoroughly studied topics can be

summarized in: anthropogenic climate change, vaccination scepticism and GMO's (Drummond and Fischhoff, 2017; Pechar et al, 2018; Rutjens et al, 2017). Each topic, and their antecedents, are discussed below.

Anthropogenic climate change

97% of the publishing climate scientists agree on that human activity is causing global warming (Cook, 2016). In other words, there is scientific consensus on the role human behaviour plays within climate change. Surprisingly, there are climate sceptics actively challenge or even deny this consensus (Oreskes, 2004; Cook, 2016). It might be tempting to think this could be due to people simply not understanding or misinterpreting science, as science can be complex and abstract. However, this notion proves to be false and too simplistic (Drummond and Fischhof, 2017; Jost et al, 2003; Rutjens et al, 2017). Interestingly, people with high science literacy and education can also be found on the sceptical side of the climate change spectrum. In fact, climate change sceptics generally do not report to have less faith in science (Drummond and Fischhof, 2017). So, if climate change scepticism cannot be explained as a simple failure to understand science, then how should it be understood?

According to prior research, climate change scepticism has a political origin (Rutjens et al, 2017; Pechar et al, 2018; Fielding et al, 2012; Hamilton et al, 2015). Multiple studies show trends in which political conservatism systematically predicts climate change scepticism. (Horseley et al, 2016; Rutjens et al, 2017; Rutjens et al, 2018; Jost et al, 2003). In other words, people who identify as political conservative are more likely to be sceptic towards anthropogenic climate change. While this trend is interesting, it does not explain why political conservatives have a higher chance of being climate change sceptics. In order to understand why political conservatism and climate change scepticism are related, it is important to first look at what political conservatism entails and what function it might fulfil.

In essence, according to prior research, political conservatism is built around two core dimensions: resistance to change and endorsement of inequality (Jost et al, 2003).

Furthermore, individuals who identify as conservatives tend to have psychological traits that associate with either one of these core dimensions. These psychological traits can be summarized in uncertainty avoidance and fear management (Jost et al, 2003). Uncertainty avoidance relates to the first dimension of conservatism; resistance to change, and fear management relates to the second dimension of conservatism; endorsement of inequality. In this sense, political conservatism can be viewed as a belief system through which individuals

resist change and endorse inequality, with the underlying goal of fulfilling psychological needs for uncertainty avoidance and fear management (Jost et al, 2003).

The process of adopting a conservative political orientation, to manage psychological needs, can be seen as a form of motivated reasoning. (Jost et al, 2003; Pechar et al, 2018; Drummond and Fischhoff, 2017; Rutjens et al, 2018; Slothuus and de Vreese, 2010). In more general terms, motivated reasoning refers to the idea that people actively seek and evaluate information, or belief systems, that support their ideals and psychological needs, while ignoring contradicting information (Drummond and Fischhof, 2017; Jost et al, 2002; Miller et al, 2015; Epley and Gilovich, 2016). Interestingly, the process of motivated reasoning seems to be particularly strong, when a specific topic induces strong emotions like fear or anxiety (Haltinner & Saratchandra, 2017). Accepting the consequences of climate change can cause psychological discomfort, especially for individuals that are generally fearful of threats. As a result, these individuals become prone to adopting a conservative ideology, in order to construct a safer narrative (Jost et al, 2003; Haltinner & Saratchandra, 2017). Within the topic of climate change, this results in scepticism (Jost et al, 2003).

The combination between uncertainty avoidance, fear management and motivated reasoning explains why political conservatism can systematically predict climate change scepticism. Individuals avoid contradicting their psychological needs by adopting a conservative political orientation and remaining ignorant. This explanation is confirmed by the observation that conservatives with higher science literacy are more likely to reject the scientific consensus on anthropogenic climate change. Mainly because conservatives, that are highly educated, are better equipped to find the 3% of studies that reject the consensus on climate change. (Drummond and Fischhoff, 2017).

Understanding climate change scepticism, could political conservatism also be an antecedent of COVID-19 scepticism? It could be argued that the recent COVID-19 related measures, ranging from regularly washing hands to radical measures such as complete lockdowns, would inevitably cause contradiction with the conservative desire to resist change. Furthermore, the topic of COVID-19 is likely to cause feelings of anxiety for large amounts of people. Similar to the topic of climate change, COVID-19 anxiety could stimulate the process of motivated reasoning, which could then lead to a conservative and sceptic view. Based on this, the following hypothesis are constructed

Hypothesis 1: An increase in COVID-19 anxiety relates to a more conservative political orientation.

Hypothesis 2: COVID-19 scepticism can be predicted through a conservative political orientation.

While it is possible that political conservatism is an antecedent of COVID-19 scepticism, it is important to note that climate change and COVID-19 are substantially different phenomena. COVID-19 is a highly contagious virus with potential individual negative health implications in the direct or near future (Harapan et al, 2020). Whereas the risks associated with anthropogenic climate change tend to be more collective, gradual and long term (Haines, 2004). Because of the acute risk associated with COVID-19, it could be harder to ignore, even if it causes great feelings of uncertainty, anxiety or general distress. For this reason, more factors could be involved. To form an idea about other potential underlying variables, the antecedents of scepticism towards vaccinations and GMO's are discussed below.

Vaccinations and genetically modified foods

Whereas an antecedent of climate change scepticism is political conservatism, multiple studies conclude that vaccination scepticism can be predicted through religiosity (Rutjens et al, 2017; Rutjens et al, 2018; Engin and Vezzoni, 2020). This might seem paradoxical - as in the western world - vaccination scepticism is increasing, while the influence of religiosity is simultaneously declining (Houtman and Aupers, 2007). However, more recent studies explain this by including spirituality as an antecedent as well (Rutjens and van der Lee, 2020).

Indeed, religion and spirituality can both be classified as ultimate explanatory frameworks. This does not mean that one is superior to the other, but different explanatory frameworks function as mutually exclusive ways to make sense of the world (Rutjens et al, 2018). For example, an orthodox religious or spiritual person, could feel troubled when faced with scientific facts that contradict deeply held beliefs or moral convictions. In this case, the person might not be able to fit certain scientific facts within their belief system. It comes as no surprise that spiritual and orthodox religious people tend to have less general trust in institutions, which mediates vaccine scepticism (Rutjens et al, 2017; Engin and Vezzoni, 2020).

In other words, vaccination scepticism stems from adherence to belief systems that mitigate trust in institutions, whether that be through religion or spirituality. It is not hard to imagine that trust in institutions might play a role within COVID-19 scepticism as well. In fact, almost all official information on the virus and associated health risks, come from

scientific sources. When trust in institutions is low, information presented by scientific institutions could be underestimated. Just as with vaccination scepticism, low trust in institutions might result in scepticism towards COVID-19 related information. For this reason the following hypothesis is constructed.

Hypothesis 3: COVID-19 scepticism can be predicted through low trust in institutions.

Until now, political conservatism and trust in institutions are important antecedents of science scepticism. Studies towards the topic of GMO scepticism introduce a lack of domain specific knowledge as an additional factor (McPhetres et al, 2019; Rutjens et al, 2017). The science behind GMO's is complex and hard to understand. It requires specific and specialised knowledge which most people do not possess. This makes understanding GMO's a difficult task. This difficulty in understanding this topic is what leads to scepticism (McPhetres et al, 2019). While multiple studies show that GMO scepticism is influenced by faith in and knowledge about science, other studies illustrated that increasing knowledge about GMO's stimulated positive attitudes towards GMO's and actively reduced scepticism (McPhetres et al, 2019; Rutjens et al, 2017, Rutjens et al, 2018; Piotr and Królczyk, 2016). In other words, knowledge about GMO's determines whether the attitude of an individual is either supportive or sceptical.

While on the surface, GMO and COVID-19 seem to be inherently different phenomena, they both share a complex and abstract nature. For the general public, it can be hard to understand what these topics are. Because of this, it might be difficult to make a consideration of potential risks. Especially for COVID-19, which is new. As of this time, there is little specific information on the exact risks of COVID-19. For example, it is not completely clear why some individuals end up hospitalized, while others remain untouched or asymptotic. Furthermore, some information regarding COVID-19 seems to be contradictory. Just as with GMO, it could be that information about the topic of COVID-19 is of key importance in the formation of either supportive, or sceptical attitudes. It can be argued, that to form a proper risk assessment, clear and understandable information is needed. Just as with GMO scepticism, a lack of this domain specific knowledge could lead to scepticism. To test whether this is the case for COVID-19, the following hypothesis is constructed:

Hypothesis 4: COVID-19 scepticism can be predicted through a lack of COVID-19 related knowledge.

COVID-19 scepticism and guideline compliance

Concluding - based on the topics of climate change, vaccinations and GMO's - science scepticism can have the following antecedents; political conservatism, trust in institutions, and a lack of domain specific knowledge. While it is not clear whether one, or multiple of these antecedents evoke COVID-19 scepticism, there are some studies towards COVID-19 guideline compliance that reference some of these antecedents. It should be noted that COVID-19 guideline compliance does not equal COVID-19 scepticism. However, because these studies reference antecedents that are fundamental within the science scepticism literature, they are interesting. For example, Plohl and Musil (2020), who studied COVID-19 guideline compliance through an international survey, built a theoretical model based on antecedents of science scepticism. The model included variables such as political conservatism, religious orthodoxy and trust in science. Ploh and Musil (2020) also incorporated COVID-19 risk perception, as an operationalisation of COVID-19 scepticism, into their model. According to their study, political conservatism was associated with trust in science as well as with COVID-19 risk perception, which then both related to guideline compliance. (Plohl and Musil, 2020).

Another study by Rothgerber et al (2020), conducted in the U.S., emphasizes the importance of political conservatism in directly explaining COVID-19 guideline compliance. Rothgerber et al (2020) argue that conservatives tend to believe less in the accuracy of mainstream media information, resulting in a 'hostile media effect'. This means that conservatives are prone to selective exposure, which results in conservatives underestimating the risk of COVID-19. Just as with anthropogenic climate change, motivated reasoning could function as an explanatory framework here. Conservatives might choose not to believe in information the mainstream media provides, as the issue of COVID-19 is heavily politicized and could clash with their ideals (Rothgerber et al, 2020). As a consequence they reference sources that confirm their ideals and beliefs, which can eventually cause conservatives to have less self-reported knowledge about COVID-19 (Rothgerber et al, 2020). While the study by Rothgerber et al (2020), does not operationalize COVID-19 scepticism specifically, it does emphasize the importance of political identity and self-reported knowledge about COVID-19 in the formation of risk perception, which according to Plohl and Musil (2020), can be seen as a form of scepticism. Brzezinski et al (2020) partly confirm the results of Rothgerber et al (2020), by reporting that beliefs about anthropogenic climate change directly influence

physical distancing patterns. In other words, people that deny anthropogenic climate change tend to also underestimate the risk of COVID-19.

Research question

While the studies of Plohl and Musil (2020), Rothgerber et al (2020) and Brzezinski et al (2020) investigate guideline compliance, they all emphasize the importance of political conservatism in explaining COVID-19 risk perception. As risk perception can be seen as a form of scepticism, political conservatism could be an important antecedent of COVID-19 scepticism specifically. Furthermore, Plohl and Musil (2020) also note trust in science as an additional variable influencing COVID-19 risk perception. Rothgerber et al (2020) further extend on this by including self-reported knowledge as a possible third variable influencing COVID-19 risk perception. While the studies on COVID-19 seem to emphasize on trust in science, instead of trust in institutions, the results of these studies seem to generally align with the constructed hypothesis. Based on these variables, the following research question is constructed: What are the antecedents underlying COVID-19 scepticism, and to which topic of science scepticism does COVID-19 scepticism best relate?

Methods

Design and procedure

To answer the research question, the relation between COVID-19 scepticism, political orientation, trust in institutions and COVID-19 related knowledge was tested. For this purpose, a quantitative research design was used. For this study no specific data was collected. Instead, an existing dataset was used. The dataset in question was originally used for a research project from the Department of Public Health at Brigham Young University (Christensen et al, 2020). The dataset contained information from an online survey on political ideology, scientific trust, media consumption, attitudes, anxieties, impacts and knowledge related to COVID-19 (Christensen et al, 2020). In order to test the hypotheses and answer the research question related to this specific study, only a subset of questions from the existing dataset were used. Participants were recruited by Qualtrics (Provo, UT, USA) through an anonymous and online survey. Completing the survey took participants 10 to 15 minutes. Before any questions were presented, participants read through an implied consent form. Meaning that participants, by completing the survey, implied consent for participation.

The implied consent form disclosed information about potential harms and benefits. Participants were presented the option to quit the survey at any time, without justification.

Participants and sampling

The original sample consisted of 1030 participants. However, for this study, 327 participants were removed (N = 703). 310 participants filled in an age lower than 18 and 17 participants hindered statistical analysis. The sample was recruited by Qualtrics (Provo, UT, USA). Quota's for sex, race and income were used to increase demographic representation. The sample consisted of 346 male respondents and 357 females respondents with a mean age of 41.46. All participants included in this study were adults and resided in the U.S. on March 31st, 2020.

Data collection instruments

To test the hypotheses and answer the research question, the following variables were operationalised:

- Dependent variables: COVID-19 scepticism and political orientation.
- Independent variables: COVID-19 related anxiety, political orientation, trust in institutions, COVID-19 related knowledge.

COVID-19 scepticism

Christensen et al (2020) did not operationalise COVID-19 scepticism in their study. However, they had multiple items in their COVID-19 related knowledge section that related to scepticism. These specific items were used to construct the COVID-19 scepticism scale, and are presented in table 1.

Table 1

Items for COVID-19 scepticism scale.

<i>Items</i>
1. Which is more deadly when contracted: the seasonal influenza virus (the flu) or COVID-19?
2. As of march 30 th , how many confirmed cases of COVID-19 do you think there are in the US?
3. As of march 30 th , how many people do you think have died from COVID-19 in the US?
4. As of march 30 th , how many of the world's 195 countries do you think have at least one confirmed case of COVID-19 within their borders?

Before a factor analysis could be performed, the 4 items had to be standardised. Item 2, 3 and 4 originally had between 8 and 11 answer categories, while item 1 only had 3. All 4 items were standardised to 3 answer categories, either not sceptical, sceptical or very sceptical. For items 2, 3 and 4 the right answer and any overestimation of cases was labelled not sceptical. Everything below the right answer was labelled either sceptical or very sceptical, based on the severity of the underestimation. The factor analysis indicated a very low correlations of item 1 with the other 3 items (.03; .03; .05). In addition, item 1 also had an unacceptable score on communalities and a relatively low factor loading (.03; .17). For this reason, item 1 was deleted from the factor analysis. The factor analysis with items 2, 3 and 4 had a KMO of .59. The solution consisted of 1 factor, which explained 48.34% of variance and had an eigenvalue of 1.45. All items scored above .4 on communalities, see table 2. The reliability analysis indicated a Cronbach's alpha of .51, which could not be increased by deleting items. After the factor and reliability analyses a mean score was computed.

Table 2

Component matrix factoranalysis COVID-19 scepticism (R2=48.34%)

Item	Communalities	Factor loading COVID-19 scepticism
1. As of march 30 th , how many confirmed cases of COVID-19 do you think there are in the US?	.51	.72
2. As of march 30 th , how many people do you think have died from COVID-19 in the US?	.55	.74
3. As of march 30 th , how many of the world's 195 countries do you think have at least one confirmed case of COVID-19 within their borders?	.39	.62
Cronbach's Alpha		.51

COVID-19 related anxiety

The items used to operationalise COVID-19 related anxiety are presented in table 3. These items were chosen because they measured fear as a consequence of COVID-19 directly. All 4 items presented in table 3 were measured using a 7 point Likert scale. 1 relating to very high anxiety and 7 relating to low anxiety.

Table 3

Items for COVID-19 related anxiety scale.

<i>Items</i>
1. I would be scared if I contracted COVID-19
2. I would be scared if an elderly family member contracted COVID-19
3. I would be scared if a very young family member contracted COVID-19
4. I would be scared if a healthy adult family member contracted COVID-19

To construct the a scale for COVID-19 related anxiety, a factor analyses with oblique rotation was performed. Every item had at least one absolute correlation greater than .3 with another item. KMO and Bartlett’s Test had a score of .80, which is reasonable. The initial solution consisted of 1 component with an eigenvalue of 3.03. Component 1 explained 75,63% of variance. The scree plot showed a kink at factor 2. Every item scored above .6 on communalities, see table 4. According to the component matrix, every item had a correlation greater than .8 with the component, see table 4. Every item was included in the reliability analysis, which reported a Cronbach’s alpha of .89. Cronbach’s alpha could not be increased by deleting items. After the factor and reliability analysis were performed, a mean score was computed.

Table 4

Component matrix factor analysis COVID-19 related anxiety ($R^2=75.34\%$)

Item	Communalities	Factorloading COVID-19 related anxiety
1. I would be scared if I contracted COVID-19	.72	.85
2. I would be scared if an elderly family member contracted COVID-19	.70	.84
3. I would be scared if a very young family member contracted COVID-19	.79	.89
4. I would be scared if a healthy adult family member contracted COVID-19	.82	.90
Cronbach’s Alpha		.89

Political orientation

The authors of the dataset used a 7 point Likert scale, ranging from extremely liberal (1) to extremely conservative (7), in which respondents self-characterised their political views, to operationalise political orientation. This scale, as operationalised by Christensen et al (2020), will be used in this study to measure political orientation as well.

Trust in institutions

Christensen et al (2020) did not operationalise trust in institutions in their study. However, they did include two dichotomous questions about trust in government and trust in scientists. These questions are presented in table 5. These two questions were standardised to either trust, or no trust, after which a sum score was computed. A score of 2 indicating high trust in institutions and a score of 0 indicating low trust in institutions.

Table 5

items for trust in science and trust in government.

<i>Items</i>
1. The government is almost always wasteful and inefficient (1). / The government often does a better job than people give it credit for (2).
2. Most scientist think global warming is happening.(1) / there is a lot of disagreement whether global warming is happening (2).

COVID-19 related knowledge

To operationalise COVID-19 knowledge, 6 items were used, see table 6. These 6 items were a selection of multiple items Christensen et al (2020) used to operationalise COVID-19 related knowledge. These 6 items were chosen, because they all seem to measure COVID-19 knowledge directly. Furthermore, other items that Christensen et al (2020) used to operationalise COVID-19 related knowledge were used to operationalise COVID-19 scepticism, see table 2. The items presented in table 6 originally had 3 answer categories; true, false or I don't know. To prepare these items for analysis, the answer categories were standardised to either true or false. With exception of items 3 and 5, most participants answered these questions right, indicating that these items indeed measured participants knowledge towards COVID-19. After standardisation, the items were sum scored. A score of 6 indicating high COVID-19 related knowledge and a score of 0 indicating low COVID-19 related knowledge.

Table 6

items for COVID-19 knowledge scale.

<i>Items</i>
1. The WHO has declared COVID-19 a global pandemic
2. There is currently an available vaccine for COVID-19
3. There are currently available medications to treat hospitalized persons with COVID-19
4. COVID-19 is thought to spread mainly from person-to-person through the inhalation of respiratory droplets produced when an infected person coughs or sneezes
5. If a person infected with COVID-19 left a room 3 hours ago, one can contract the virus by walking into that empty room and breathing the air.
6. One can contract COVID-19 by touching infected surfaces and then touching your nose or mouth

Data analysis approach

The data analysis was conducted in the data analysis program IBM SPSS Statistics 26. Two regression analyses were performed to test the 4 hypotheses. The first regression analysis consisted of a simple linear regression model. This analysis was performed to determine whether COVID-19 related anxiety impacted political orientation. To test hypotheses 2, 3 and 4, an additional multiple linear regression analysis was performed. This second analysis consisted of three models. In the first model, it was tested whether political orientation impacted COVID-19 scepticism. In model 2, trust in institutions and COVID-19 related knowledge were added. Finally, in model 3, age and sex were entered as control variables. The regression analyses were chosen, because they allowed an estimation of the relationships between the dependent and different independent variables. In addition, the second regression analysis, indicated what variables had the biggest impact on COVID-19 scepticism, which was a key insight in answering this study's research question. Because both age and COVID-19 related knowledge had an effect on COVID-19 scepticism, an additional interaction analysis was performed. In this analysis, it was tested whether age moderated the effect of COVID-19 related knowledge on COVID-19 scepticism.

Ethical considerations

Before accessing the data from the Department of Public Health at Brigham Young University, a form was signed including a promise of confidentiality. Furthermore, the data was stored in a safe online environment, minimizing the risk of a potential data leak. The

dataset received ethical approval from the Brigham Young University Institutional Review Board. In addition, approval to use the dataset for this study was provided by UU-SER.

Results

Preliminary analyses

An overview of descriptive statistics for this study's variables are presented in table 7. The average participant tended to feel high anxiety towards COVID-19, and reported to have relatively high COVID-19 related knowledge. Before interpreting the results of the regression analyses, assumptions of linearity, homoscedasticity, independence and normality were checked. Both dependent variables, political orientation and COVID-19 scepticism, showed a normal distribution, see appendix 1. However, the standardised residuals had a minimum value of -3.03 and a maximum value of 2.48. Because a minimum value of 3.03 is unacceptable, 9 respondents were removed. After removal, the minimum value was 2.67, which is acceptable. Mahalanobis distance had a minimum value of 1.47 and a maximum value of 28.6. To keep the Mahalanobis distance within acceptable range, 8 more respondents were removed.

Results

After the assumptions were met, the analyses were interpreted. The results are presented in table 8 and 9. The first regression analysis indicated an effect of COVID-19 related anxiety on political orientation. In contrast with hypothesis 1, a decrease in COVID-19 related anxiety was able to predict a more conservative political orientation ($b=.23$; $p<0.001$). The second regression analysis consisted of 3 models, see table 9. Hypothesis 2, that stated that COVID-19 scepticism could be predicted through a conservative political orientation, was rejected. Political orientation had no effect on COVID-19 scepticism ($b=.01$; $p>0.05$). Hypotheses 3, that stated that a low trust in institution would predict COVID-19 scepticism was rejected as well, as trust in science had no effect on COVID-19 scepticism ($b=.02$; $p>0.05$). However, in line with hypothesis 4, COVID-19 related knowledge predicted COVID-19 scepticism in both models ($b=-.12$; $p<0.001$). More knowledge about COVID-19 related to less COVID-19 scepticism. Interestingly, age was able to predict COVID-19 scepticism as well ($-.01$; $p<0.001$). As age increased, COVID-19 scepticism decreased. In other words, older respondents tended to be less sceptic towards COVID-19.

As age and knowledge both had an effect on COVID-19 scepticism, an additional analysis was performed. It was tested whether age increased the effect of COVID-19 knowledge on COVID-19 scepticism. As table 10 indicates, several variables had high correlations. To circumvent issues regarding multicollinearity, centred values for COVID-19 scepticism, COVID-19 related knowledge and age were computed. The results of the interaction analysis are presented in table 11. Age interacted with COVID-19 related knowledge in predicting COVID-19 scepticism ($b=-.004$; $p<0.01$), see figure 1. Higher scores on knowledge related to less scepticism. As illustrated in figure 1, age moderated this relation. The effect of knowledge on scepticism was stronger for young participants (age <41). As age increased, the effect of knowledge on scepticism decreased. In other words, young participants that scored high on COVID-19 knowledge tended to be less sceptic towards COVID-19, when compared to older participants that scored high on COVID-19 knowledge.

Table 7

Descriptive statistics.

Variabele	N (%)	M	SD	Min	Max
Sex					
- Man	346 (49,2%)				
- Woman	357 (50,8%)				
Age	703	41.46	13,62	18	63
COVID-19 scepticism	703	1.67	.53	1	3
COVID-19 anxiety	703	1.86	1.07	1	7
Political orientation	703	4.39	1.67	1	7
Trust in institutions	703	1.19	.03	0	2
COVID-19 knowledge	703	4.49	1.02	0	6

Table 8

Regression table with dependent variable political orientation.

	Model 1
	b (se)
COVID-19 related anxiety	.23 (.06)***
R ²	.02

* $P<0.05$; ** $P<0.01$; $P<0.001$ ***

Table 9

Regression table model 1, 2 and 3 with dependent variable COVID-19 scepticism.

	Model 1	Model 2	Model 3
	b (se)	b (se)	b (se)
Political orientation	.01 (.01)	.002 (.01)	.002 (.01)
Trust in institutions		.02 (.03)	.01 (.03)
Covid-19 knowledge		-.12 (.02)***	-.12 (.02)***
Age			-.01 (.00)***
Sex			.03 (.04)
R ²	.00	.05	.07

* $P < 0.05$; ** $P < 0.01$; $P < 0.001$ ***

Table 10

Correlation table age, knowledge and scepticism.

	Age	Scepticism	Knowledge	Age * knowledge
Age	1	.16**	.10*	.83**
scepticism	.16**	1	.24**	.23**
Knowledge	.10*	.24**	1	.61**
Age *	.83**	.23**	.61**	1
Knowledge				

* $P < 0.05$; ** $P < 0.01$; $P < 0.001$ ***

Table 11

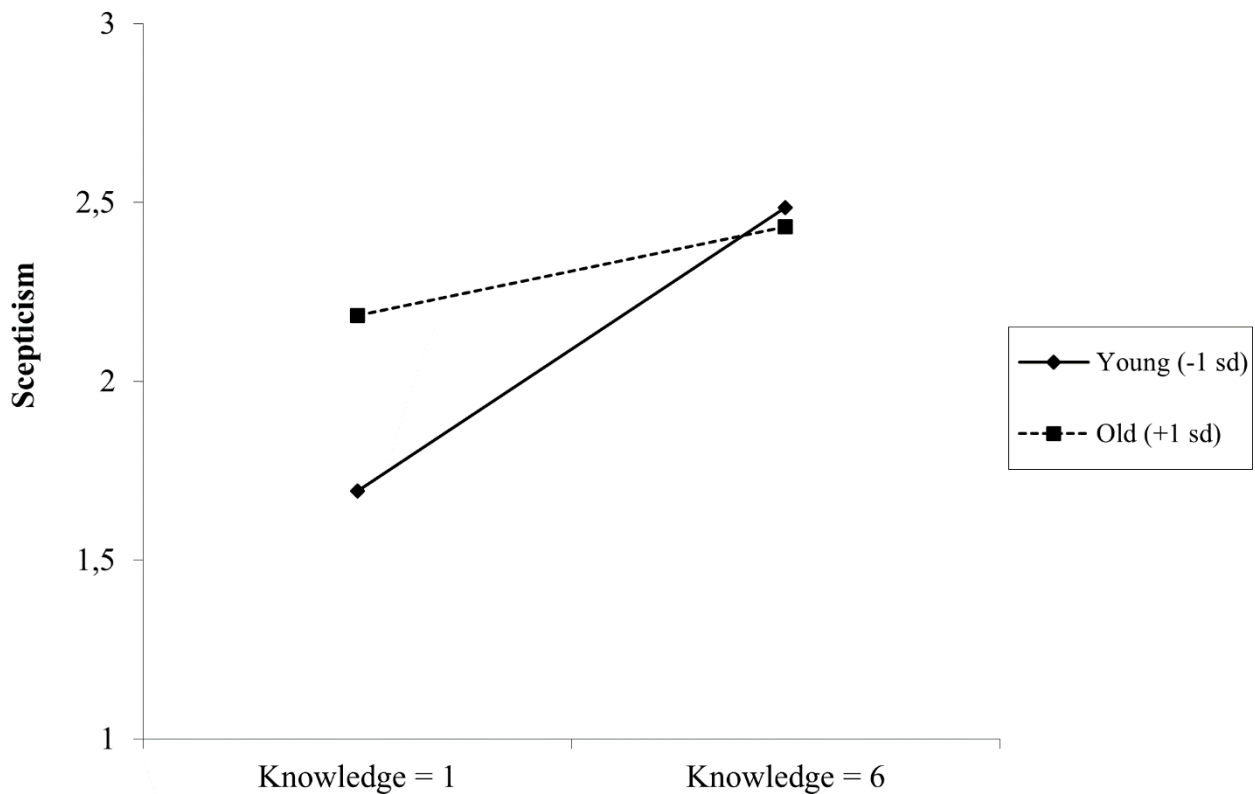
Interaction model 1 (centred variables).

	Model 1
Age	.01(.00)***
COVID-19 knowledge	.11(.02)***
Age * COVID-19 Knowledge	-.004(.001)**

* $P < 0.05$; ** $P < 0.01$; $P < 0.001$ ***

Figure 1

Interaction model COVID-19 scepticism, covid-19 related knowledge and age.



Discussion

Earlier research towards the mechanisms of scepticism mainly focuses on three controversial scientific topics: climate change, vaccinations and GMO's. The present study investigated whether one, or multiple, of the antecedents of these forms of scepticism related to COVID-19 scepticism. Interestingly, COVID-19 fear was able to predict a conservative political orientation, and COVID-19 knowledge related to COVID-19 scepticism. Surprisingly, age was able to predict COVID-19 scepticism as well. Because COVID-19 knowledge and age both had an effect on COVID-19 scepticism, two additional interaction analysis were performed. Age moderated the relation between COVID-19 knowledge and COVID-19 scepticism, indicating that the effect of COVID-19 knowledge is especially strong for young participants.

COVID-19 fear, Political orientation and COVID-19 scepticism

Contrary to what was expected, a decrease in COVID-19 related anxiety was able to predict a conservative political orientation. In other words, participants that experienced less anxiety towards COVID-19 were more likely to adopt a conservative political orientation. This is in direct contrast with the topic of climate change, in which individuals that experienced climate change anxiety, adopted a conservative ideology to manage fear.

While this finding is contradictory, it can be explained. First, it is important to note that the core of conservatism is not only to manage fear, but to resist change as well. As COVID-19 caused radical and widespread societal changes, it is possible that individuals experienced a period of great uncertainty. In this case, instead of functioning as a way to cope with anxiety, a conservative ideology could have functioned as a framework to cope with uncertainty instead. In this case, it would make sense that especially those individuals that experienced little COVID-19 anxiety, were the ones adopting a conservative orientation in order to resist change. However, if this were the case, it could be expected that individuals that used political conservatism to resist COVID-19 related changes, would at least report some COVID-19 scepticism. Yet, once again contrary to climate change scepticism, this study found no effect of political orientation on COVID-19 scepticism.

Still, it should be noted that that this study was performed with data that was gathered in the first wave of the corona pandemic. It could be, that it was simply too early for scepticism and insufficient guideline compliance to set in. Initial surprise could have masked a potential relation between political conservatism and scepticism. The results might be different when the same analysis are performed on more recent data. Yet, for now, based on these findings, it can be concluded that COVID-19 scepticism is significantly different from climate change scepticism.

trust in institutions & COVID-19 scepticism

Trust in institutions had no effect on COVID-19 scepticism. Based on the findings of this study, the mechanisms underlying COVID-19 scepticism seem unrelated to that of vaccination scepticism. Within vaccination scepticism, adherence to believe systems such as religion or spirituality lead to lower trust in institutions. As there is no link between trust in institutions and COVID-19 scepticism, it is unlikely that believe systems such as religiosity or spirituality are underlying factors within this specific topic. The effect of COVID-19 knowledge on COVID-19 scepticism reinforces this idea. Most knowledge about COVID-19 is provided by scientific and/or governmental institutions. As the average participant reported

to have relatively high COVID-19 related knowledge, it can be concluded that most participants took information from scientific sources seriously. In other words, these findings seem to complement each other.

COVID-19 Knowledge, age and scepticism

A lack of COVID-19 related knowledge was able to predict COVID-19 scepticism. As the literature towards GMO scepticism indicates, insufficient knowledge about scientifically abstract and complex phenomena leads to scepticism. It is likely that, given these results, COVID-19 can be considered a complex and abstract scientific issue. This is an important finding because it illustrates that, contrary to scepticism related to climate change, providing information about COVID-19 can truly be a valuable strategy in reducing scepticism. As COVID-19, at least based on these results, does not relate to political orientation, there seems to be little risk of political conservatives using motivated reasoning to arrive at sceptical or ideologically suitable conclusions. Interestingly, the effect of COVID-19 related knowledge on COVID-19 scepticism was stronger for young participants. This indicates that providing information has the biggest effect when young groups are targeted. It should be noted that older participants tended to be less sceptic in general, this could explain why the effect of COVID-19 knowledge was smaller for participants older than 41.

It is important to note that the timing of this study in the early stages of the pandemic might have played a role in this relationship as well. Because at the time of data collection, relatively little was known about the new corona virus, the value and impact of COVID-19 related knowledge could have been stronger than in later stages of the pandemic. It is possible, that in later waves of the corona pandemic, the effect and value of COVID-19 related knowledge will decrease or even disappear.

Conclusion

The results of this study indicate that the mechanisms underlying COVID-19 scepticism differ from the antecedents of climate change and vaccination scepticism. This study shows that the mechanisms underlying COVID-19 scepticism are most similar to that of GMO scepticism. Both topics are scientifically abstract and complex and within both topics, scepticism is influenced by domain specific knowledge. However, whether disbelief in COVID-19 and GMO's can truly be seen as similar forms of scepticism remains to be seen. As mentioned earlier, COVID-19 is a much more recent issue and, especially in the beginning, COVID-19 was surrounded by a lot of ambiguity and fear. Furthermore, in contrast with GMO's, age

proved to be an important antecedent within COVID-19 scepticism. Whether in later stages of the pandemic, scepticism towards COVID-19 would still show similarities to GMO scepticism is unclear. To study COVID-19 scepticism and its antecedents more thoroughly, data on all waves of the corona pandemic should be analysed.

Limitations and contributions

As this project was written during the second and third wave of the pandemic, limited data was available. Future studies could reconstruct this study with more complete data. It could be, as the initial shock surrounding COVID-19 subsided, the virus evoked less fear. Furthermore, the topic of COVID-19 has become more politicized the last year. All these factors, that developed in later stages of the pandemic, were not accounted for in the current study.

While only analysing data from the first wave of the corona pandemic can be seen as a limitation of this study, it can be interpreted as a strong point as well. The data used in this study provides insight in the development of scepticism in a very critical stage of a pandemic; the initial outbreak. It can be argued that insight in the development of scepticism, especially within the first wave, is of great importance. Getting control over the situation as soon as possible, within those circumstances, is paramount. The results in this study emphasize the importance of knowledge and age within the development of initial scepticism, this can potentially be a valuable insight for countering scepticism in the current COVID-19 crisis, as well as during future outbreaks.

While only analysing data related to wave 1 of the corona pandemic can be defended, it should be noted that this study was also limited by the operationalisation of the variables COVID-19 scepticism, COVID-19 knowledge and trust in institutions. The data collected by Christensen et al (2020) did not operationalise these variables specifically. In order to proceed with the current study, items regarding COVID-19 scepticism and knowledge had to be selected from within the existing questionnaire. This resulted in narrow definitions of these constructs, which translated to low reliability scores on the scales of COVID-19 scepticism and COVID-19 knowledge. In other words, it is likely that the results of this study were impacted by the difficulties in the operationalization process. Future research towards this topic could improve on this study by operationalising the important variables more thoroughly. While the operationalisation process cannot be considered a strong point of this study, the dataset of Christensen et al (2020) did provide a large sample size, which makes the

results more reliable. Moreover, the use of existing data allowed this project to be finished within half a year.

Finally, the main contribution and strong point of the current study is that it analysed the mechanisms of scepticism within the very recent, and until now, unexplored topic of COVID-19. The current study should be seen as an initial exploration in mechanisms underlying scepticism towards COVID-19, that was conducted using existing data. As data and information about COVID-19 will grow, more thorough analyses can be performed. For now, the most important implication of the current study is that during the initial stages of a pandemic, people and young people in particular, should be provided with information about the phenomena. This will reduce scepticism, and in turn, reduced scepticism can lead to increased guideline compliance. As an increase in guideline compliance helps getting control over an outbreak, governments could use this information to design policies for future pandemics, in which they target young people in particular. As COVID-19 illustrated, the world was not ready for a pandemic. The implications of this study help to provide insight in how to accurately prepare for the next one.

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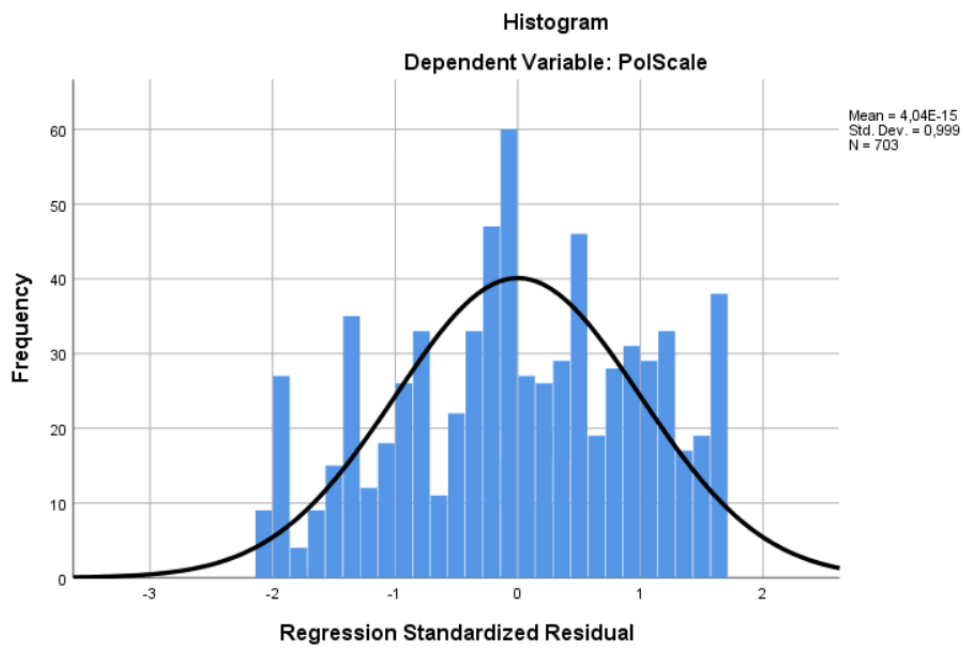
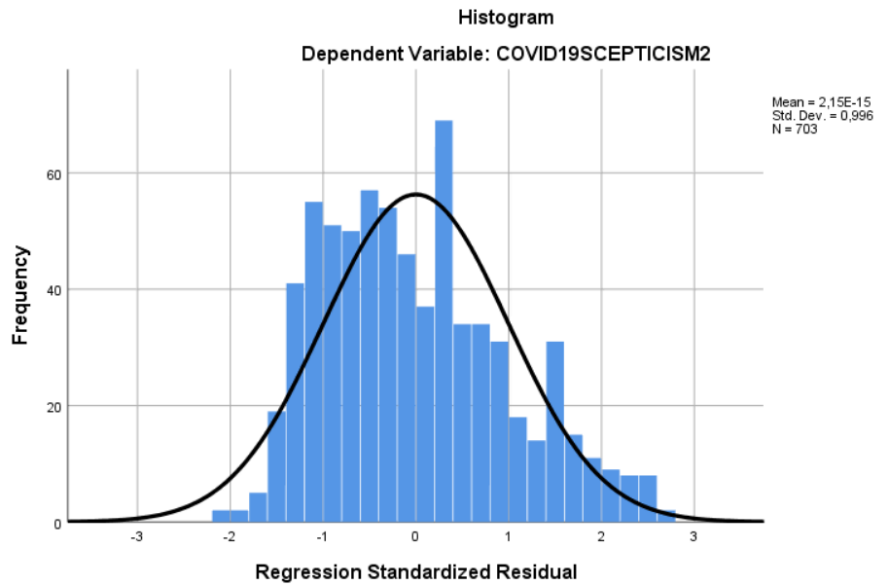
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Appendix 1

Distribution of dependent variables COVID-19 scepticism and political orientation.

Charts



Appendix 2

Social and scientific relevancy

COVID-19 is a global health crisis (Wiebers and Feigin, 2020). Understanding the underlying explanatory mechanism of scepticism towards this phenomenon could produce relevant implications for future policies or initiatives aimed at reducing the spread of the virus.

Understanding COVID-19 scepticism is important, because it provides further indication on how to flatten the curve and solve this situation of crisis (Gupta, 2020). It is likely that, when less people become sceptic towards COVID-19, guidelines will be followed more closely (Plohl and Musil, 2020). Furthermore, understanding the antecedents of COVID-19 scepticism could also be useful in combatting a potential future pandemic.

From a scientific point of view, this study could prove to be of value because existing research towards COVID-19 scepticism is scarce. Furthermore, in the research that exist, there is not yet a clear consensus on what antecedents seem to be most important in explaining COVID-19 scepticism specifically. This study adds to the existing literature, by further examining the relation between political conservatism, COVID-19 related knowledge, trust in science and COVID-19 scepticism.

Reflection on interdisciplinarity

Science scepticism is a complex phenomenon. This also shows in the theoretical framework. Different scientific topics have differing antecedents related to scepticism. Because of this, it is important to reference several disciplines in order to make sense of what scepticism towards COVID-19 entails. In the theoretical framework, several disciplines are used to explain science scepticism. For example, within climate change scepticism, psychological traits, that stem from psychology are linked with the theory of motivated reasoning. The theory of motivated reasoning stems from social psychology. While psychological traits are mentioned within the topic of climate change scepticism, theories from social psychology are most frequently used. The idea of worldviews and belief systems that are mentioned within vaccination scepticism are further examples of this. While social psychology is mostly referenced, I would say that the relevance of this study transcends just the discipline of psychology and social psychology. As implications derived from this study could be relevant within the subdomain of infectious disease control as well. Furthermore, social psychology

can also be seen as an interdisciplinary approach in itself, as it combines multiple fields such as social policy, work and mental health.

To answer the research question, a quantitative research design will be used. This design was chosen because the goal of this study is to determine whether already existing explanatory mechanisms can be extended to COVID-19 scepticism specifically. If this study shows that none of the, until now considered, important antecedents of science scepticism relate to COVID-19, a explorative study could be a next step.