

Fake News Susceptibility, an investigative study into potential factors that reduce the effect of analytical thinking.

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Introduction

On the afternoon of December fourth, 2016, a 28-year-old man entered a pizza restaurant named ‘Comet Ping Pong’ in Washington D.C. armed with an assault rifle and various other weapons. As he claimed himself, he wanted to investigate a so-called ‘paedophile child trafficking ring’ that would have been operational in the basement of the restaurant based on the various fake news articles that he had consumed on the internet (BBC, 2016; NYTimes, 2016). A few years later, on the sixth of January 2021, an angry mob, fuelled by a widespread of fake news which suggested that the winning democratic party had committed fraud, stormed the United States Capitol. The scenes of collective rage and chaos that followed resulted in the death of five individuals and left many injured, including 140 police officers (Washingtonpost, 2021; Nichols, 2021).

The aforementioned incidents are two out of many examples in which an individual, or a group of individuals, is deceived by substantial amounts of so-called fake news. Fake news is a specific type of disinformation, as it consists of deliberately fabricated information with the intention to deceive its recipients for financial or ideological gain and it tries to do so by mimicking a news format (Tandoc, 2019; Pennycook & Rand, 2019). However, while fake news has always existed it has become more dangerous and prominent in recent years due to the rise of social media (Pennycook & Rand, 2019, 2021, Beauvais, 2022; Diehl & Lee, 2022; Young, 2021). That is, as fake news is being shared in an increasingly rapid fashion on social media platforms (European Commission 2018, p. 5) it is likely that its effects will become more salient, dangerous and frequent in their occurrence.

This increasing spread of fake news and its societal impact has generated the needed scholarly interest from the particular field of social- and behavioural science (Young, 2021; Roozenbeek et al., 2022). That is, extensive research has been conducted on the topic with the aim of uncovering the psychological drivers that make individuals susceptible to it (Pennycook & Rand, 2019, 2021; Roozenbeek et al., 2022; Ecker et al., 2022; MacFarlane et al., 2020; Beauvais, 2022). Throughout this body of research there exist two overlapping theoretical accounts as to why an individual can be either more or less susceptible to fake news, namely the “classical reasoning” account and the “motivated reasoning” account (van der Linden, 2022; Roozenbeek et al., 2022).

In short, the classical reasoning account states that a lack of analytical thinking is the main predictor of fake news susceptibility. That is, individuals who actively engage in more deliberate and reflective thinking, i.e. analytical thinking, are better at discerning fake news from real news when compared to those who remain reliant on automatic and intuitive thinking. (Pennycook & Rand, 2019; 2021; Diehl & Lee, 2022; Kantonowicz-Reznichenko et al., 2022). In contrast to the classical reasoning account, the motivated reasoning account argues that pre-existing values, beliefs, goals, and affinities to social groups can influence cognitive processes in such a way that an individual will start out their reasoning process with a pre-determined goal and subsequently interpret information in the service of this goal (van Bavel & Pereira, 2018; Pereira et al., 2021, van der Linden; 2022; Druckman & McGrath,

2019; Baptista & Gradim, 2022; Szebeni et al., 2021). In this way, an individual will be unconsciously motivated to reject any information that does not align with his or her values and beliefs.

Up until now, the empirical evidence points more strongly towards the classical reasoning account. Namely, it appears that individuals who are more likely to engage in analytical thinking are better at discerning truth from lies when it comes to fake news regardless of pre-existing values, beliefs or goals (Faragó et al., 2023; Erlich et al., 2023; Pennycook & Rand, 2019; Borukhson et al., 2023). However, the protective effect of analytical thinking regarding fake news susceptibility should not be exaggerated. Namely, there are instances in which partisanship (one's affiliation with a certain political group) still causes highly analytical individuals to be more susceptible to politically congruent fake news (Faragó et al., 2023; Gawronski, 2022; Roozenbeek et al., 2022). In addition, multiple tests of interventions that were designed to nudge accuracy (i.e. analytical thinking) resulted in mixed findings as these did not always increase identification of fake news articles and even if they did the impact was only minor (Roozenbeek et al., 2021; Lutzke et al., 2019; Pennycook et al., 2020). Because of the latter, scholars have posed the question on the possible factors that can strengthen or weaken the effect of analytical thinking on fake news susceptibility (Faragó et al., 2023; van der Linden, 2022; Pennycook & Rand, 2019).

This study aims to investigate two factors that can possibly reduce the protective effect of analytical thinking regarding fake news susceptibility. That is, firstly, the strong effect of analytical thinking might be less apparent when fake news covers highly complex issues. More specifically, Pennycook and Rand (2019) argue that 'even the most reflective members of the general population cannot overcome their lack of training and knowledge in the realm of, for example, climate science' (p. 47). In this sense, one's engagement in analytical thinking could have less of an effect when fake news covers issues that are highly complex and therefore require a lot of knowledge and/or intellectual capacity, as compared to more simplified issues. Secondly, individuals need a certain motivation to engage in analytical thinking in the first place. The so-called Heuristic Systematic model (HSM) depicts this motivation in terms of one's level of involvement. That is, those individuals' that are more involved within a certain issue are more likely to engage in analytical thinking when processing information when compared to individuals that are less involved (Ali et al., 2018; Koch et al., 2023). In this sense, a low level of involvement can also decrease one's engagement in, and subsequently the effect of, analytical thinking. Hence, both complexity and involvement could possibly reduce the effect of analytical thinking and therefore increase one's susceptibility to fake news. Therefore, it is detrimental that both factors are examined to further improve the efforts of researchers and practitioners in the ongoing battle against disinformation. The role that these factors play in the relationship between analytical thinking and fake news susceptibility will be examined by answering the following research question:

'In what way do complexity and level of involvement influence the protective effect of analytical thinking on fake news susceptibility'.

Theoretical Framework

To examine the role of both complexity and involvement within the relationship between analytical thinking and fake news susceptibility, it is best to first cover the exact workings of the classical reasoning account and to uncover why it is seen as a major factor in explaining fake news susceptibility.

Dual-process theory: Two ‘systems’ of cognition. In general, the classical reasoning account argues that susceptibility to fake news is supposedly caused by an individuals’ reliance on quick and intuitive reasoning, as opposed to more careful deliberation, when confronted with the deceitful information (Pennycook & Rand, 2019; 2021; Diehl & Lee, 2022; Faragó et al., 2023; Borukhson et al, 2022). The account is based on the so-called dual-process theory which argues that human cognition can be characterized by two distinct forms. These forms are generally defined as ‘system 1’ and ‘system 2’ (Kahneman, 2011; Evans, 2003; Evans & Stanovich, 2013).

Firstly, system 1 refers to the aforementioned quick and intuitive reasoning. That is, this system of cognition consists of processes that are rapid and automatic as well as that they require no effort or sense of voluntary control (Evans & Stanovich, 2013; Kahneman, 2011; Evans, 2003). In this sense, this type of thinking is mainly characterized by autonomous and intuitive responses that come to mind directly as a response to a stimulus (Pennycook & Rand, 2021). A prime example of such a response is that of the ball and the bat problem in which individuals are subjected to the following case: ‘A baseball bat and a ball cost €1.10 in total. The bat costs €1.00 more than the ball. How much does the ball cost?’. This problem triggers a fast, intuitive response (namely, that the ball costs €0.10) that upon closer inspection is wrong (if the ball costs €0.10, the bat would cost €1.10, and they would together cost €1.20). However, as depicted by Pennycook and Rand (2019) this incorrect intuitive response, produced by system 1, is still chosen 65% of the time.

In contrast to system 1, so-called system 2 reasoning consists of more effortful, deliberative and analytical processes (Kahneman, 2011; Evans & Stanovich, 2013; Evans, 2003). The system is described by Kahneman (2011) as ‘the conscious, reasonable self that has beliefs, makes choices, and decides what to think and what to do’ (p. 21). In other words, system 2 reasoning refers to one’s conscious processes like decision making, reflection and deliberation. Hence, when applied to the same problem of the ball and the bat, it is because of one’s careful deliberation produced by system 2 that the correct answer (€1.05) will be given. Thus, whereas system 1 consists of unconscious, autonomous and intuitive reasoning, system 2 consists of more effortful, deliberative, and reflective reasoning. The question that remains then is how dual-process theory explains fake news susceptibility.

Classical reasoning: The corrective function of system 2. When applied to the phenomenon of fake news, it is the intuitive and automatic reasoning processes of system 1 that are causing an individual to become susceptible to it. That is, system 1 processes are prone to heuristic biases that make for easy and fast cognition but result in poor accuracy of judgement (Kahneman, 2011; Kantonowicz-

Reznichenko et al., 2022; Evans & Stanovich, 2013). However, these shortcomings of system 1 can be overcome through engagement in the deliberate and effortful processes of system 2 (Kahneman, 2011; Pennycook & Rand, 2019; 2021). This engagement in system 2 reasoning can be seen as the most important premise of the classical reasoning account.

Namely, scholars seem to agree about the fact that the deliberate and effortful processes of system 2 serve as a correctional agent that can overrule the intuitive reasoning and subsequent cognitive biases of system 1 (Pennycook & Rand, 2019; 2021; Diehl & Lee, 2022; Erlich et al., 2023; Faragó et al., 2023;). The latter is depicted in a variety of research which found that an individuals' engagement in analytical thinking (read: system 2 reasoning) reduces fake news susceptibility. That is, firstly, Pennycook and Rand (2019; 2021) found that high scores on the so-called Cognitive Reflection Test (CRT), a test that is narrowly linked to one's propensity for engaging in deliberative and effortful system 2 reasoning, are negatively correlated with perceived accuracy of fake news. In addition, both Kantorowicz-Reznichenko et al. (2022) and Swami et al. (2014) found similar results, as both studies indicate that deliberative thinking reduces one's belief in conspiracy theories, which are often part of fake news articles, as well. Thus, those individuals that engage in analytical thinking seem to better at discerning truth from lies when reading (fake) news articles.

Secondly, Diehl and Lee (2022) add that individuals who hold a so-called News Finds Me Perception (NFMP), representing a low-effort cognitive style of attention to news (read: reliance on system 1), are more likely to evaluate fake news as credible. Again, this indicates that an intuitive and low-effort style of reasoning makes individuals susceptible to fake news, as it allows for the heuristic biases to influence one's judgement. In fact, recently conducted studies by Faragó et al. (2023) and Erlich et al. (2023) show that the importance of analytical thinking in fake news susceptibility also holds within highly polarized environments wherein a flood of disinformation is apparent throughout daily life. That is, the work of Faragó et al. (2023) was conducted in Hungary in which, according to the authors, systematic disinformation campaigns are being held by pro-government news outlets. Still, the study found that individuals that possess higher analytic thinking (also measured by applying the CRT) were better at discerning disinformation. Similarly, Erlich et al. (2023) analyzed the effect of pro-Kremlin disinformation among a Ukrainian sample, which is a highly polarized context since the start of the Russo-Ukrainian war in February 2022. The results of the study again indicated that analytic thinking, as measured by the CRT, was associated with truth-discernment. More importantly, the effects held even for those Ukrainians amongst the sample that were strongly oriented towards Russia and would have likely been more susceptible to the pro-kremlin disinformation.

Thus, the classical reasoning argues that the automatic and intuitive system 1 makes individuals susceptible to fake news and provides robust evidence for the correctional effect of the effortful and deliberate reasoning produced by system 2. However, the effect of analytical thinking is not always apparent as interventions that were based on the classical reasoning account yielded mixed- and minor results (Lutzke et al., 2019; Roozenbeek et al., 2021; Pennycook et al., 2020).

Issue complexity: The limits of analytical thinking. Even though scholars widely acknowledge that analytical thinking effectively reduces one's susceptibility to fake news, recent interventions that were based on the classical reasoning account resulted in somewhat contradictory findings. Namely, whereas both Pennycook et al. (2020) and Mirhoseini et al. (2023) found that interventions aimed at priming analytical thinking within individuals successfully resulted in higher rates of truth discernment (the correct identification of true and false news), similar interventions resulted in more conservative insights about the effect of analytical thinking on fake news susceptibility.

That is, firstly, Roozenbeek et al. (2021) tested an intervention that primed analytical thinking as well. A treatment group of participants was asked to think about the accuracy of single news headline, in order to prime analytical thinking, whereafter they were asked to rate true and fake news headlines about COVID-19. Whereas the first intervention was unsuccessful, a second intervention with an increased amount of participants resulted in a small but significant effect between the accuracy nudge and subsequent truth discernment of the COVID-19 headlines. Hence, participants that were triggered to think about the accuracy of a news headline were subsequently better at discerning true and fake news headlines, but the effect was only minimal (1.4 times higher than the control group). The authors gave various interpretations of their failed first intervention and the marginal result of the second one, including the possibility that 'the effectiveness of accuracy nudges varies across time and issue domains' (p. 7). In other words, analytical thinking was seemingly less effective in the specific issue domain of COVID-19, which could hypothetically be possible due to the fact that the underlying medical science associated with the COVID-19 pandemic requires extensive training and domain-specific knowledge to truly understand. In fact, basic science knowledge has been positively associated with truth discernment for (dis)information about COVID-19 (Pennycook et al., 2020).

Secondly and in a similar fashion, Lutzke et al., (2019) examined whether interventions that primed analytical thinking in individuals influenced their evaluation of the credibility of real and fake news about climate change. The study found that participants that were exposed to guidelines on how to evaluate the credibility of a news article, which primed analytical thinking, reported a reduced likelihood to trust, like and share fake news about climate change and thereby reaffirmed the protective effect of analytical thinking as well. However, similarly to Roozenbeek et al. (2021) the authors state that the measured effects were only minor and, more importantly, that 'several challenges – e.g. low levels of domain-specific knowledge about climate change – continue to stand in the way of interventions designed to address the problem (p. 7) as those with less domain specific knowledge were more likely to trust fake climate news.

Hence, it seems that the protective effect of analytical thinking regarding fake news susceptibility can be limited when one does not possess the required domain-specific knowledge about the issue that is portrayed. In a similar fashion, Pennycook and Rand (2019) state that 'Thinking analytically about extremely complex scientific issues is not likely to have a directional effect because the factors that climate scientists think about when judging the likelihood of anthropogenic global

warming will not be the same as the factors that lay people think about' (p. 47). In fact, relevant prior knowledge about a topic is known to impact one's acceptance of (fake) news messages (Pennycook & Rand, 2021; Beauvais, 2022; van der Linden, 2022; Ecker et al., 2022).

Thus, it appears that while analytical thinking can effectively reduce one's susceptibility to fake news, its effect is possibly moderated by the level of complexity of the issue that is portrayed in the message. Hence, interventions aimed at reducing susceptibility to fake news surrounding highly complex issues in the likes of medical science (COVID-19) and climate science resulted in minor effects that were likely caused by a lack of domain-specific knowledge among participants. In this sense, it is plausible that the effect of analytical thinking will be reduced when an individual is confronted with highly complex information within (fake) news articles as opposed to information that is more understandable for the average individual. However, apart from complexity being a possible moderator for the protective effect of analytical thinking, a second possible factor that can reduce its effect lies in the fact that an individual needs a certain motivation to engage in analytical thinking in the first place.

The HSM: The importance of motivation. While the classical reasoning account draws on dual-process theory to explain fake news susceptibility, only little attention is given to the fact that an individual needs a certain motivation to engage in System 2 reasoning (read: analytical thinking). That is, humans are so-called cognitive misers that typically like to avoid effortful cognitive processes and therefore need to be motivated to engage in them (Kahneman, 2011). The research on the classical reasoning account of fake news susceptibility aims to capture this engagement in System 2 reasoning through the use of the CRT, a test that measures one's propensity to engage in analytical thinking based on both numerical and non-numerical problems that one needs to solve. However, while the test gives an indication of one's propensity to engage in analytical thinking, it does not tell exactly why this individual was motivated to think deliberately about a certain topic.

A model that is based on the same dual-process theory, the so-called Heuristic Systematic Model (HSM), provides a richer context behind one's motivation to engage in more deliberate analytical thinking. Namely, according to the HSM it is one's level of involvement that determines whether he or she will be persuaded by information through either a central route or a peripheral route (Ali et al., 2022; Koch et al., 2023). That is, higher levels of involvement will cause an individual to be persuaded through a central route by engaging in scrutiny and thoughtful processing (read: analytical thinking or system 2 processing) of the message, whereas low levels of involvement will lead to persuasion through a peripheral route that is based on associative memory and low cognitive effort (read: intuitive thinking or System 1 processing). Thus, higher levels of involvement will likely cause an individual to engage in analytical thinking when confronted with a certain piece of information, whereas lower levels of involvement will likely cause an individual to refrain from thinking deliberately and rely on intuitive thinking. In fact, Koch et al. (2023) studied the effect of involvement in the context of perceived credibility of fake news and found that higher levels of involvement were associated with one's self-

reported likelihood to elaborate on a topic, engage with others about a (fake) news post and to search for more information. Thus, there are indications that high involvement with a topic causes individuals to think twice about a certain piece of information instead of leaning on the quick mechanics of intuitive reasoning.

The current study. In sum, fake news proves to be a profound threat to society and scholars in the field of social- and behavioural science are conducting extensive research on the psychological drivers that make individuals susceptible to it. Throughout this body of research, a scholarly debate appears to exist between two theoretical accounts of fake news susceptibility, namely the classical reasoning account and the motivated reasoning account, and the empirical evidence most strongly points towards the classical reasoning account. That is, the majority of studies indicate that in most cases it is one's engagement in deliberate analytical thinking that reduces fake news susceptibility as it seemingly overrules one's intuitive reasoning and subsequent cognitive biases. As analytical thinking seems to be the most important psychological driver in reducing fake news susceptibility, this study firstly aims to retest this assumption through the following hypothesis:

H1: Individuals who engage in analytical thinking will be more likely to identify fake news; those who score higher on analytical thinking will rate real news as more accurate and fake news as less accurate

Hence, it is expected that the relationship between engagement in analytical thinking and news accuracy ratings (i.e., correctly rating real news as accurate and fake news as inaccurate) will be positive. However, it appears that this protective effect of analytical thinking on one's fake news susceptibility should not be exaggerated and thus needs to be examined further. Hence, knowing when analytical thinking fails to protect individuals against fake news is detrimental if one wants to effectively deal with the consequences of the deceptive information. Two factors that could reduce the effect of analytical thinking will therefore be examined in this study. Firstly, recent tests of interventions that are based on the classical reasoning account depict that the protective effect of analytical thinking may be limited by the complexity of the issue that is portrayed within fake news articles, for instance in the likes of highly complex climate science or equally complex medical science (i.e., fake news surrounding COVID-19). In this sense, the protective effect of analytical thinking will be weaker when the information portrayed in a fake news article is perceived as highly complex. Therefore, the second hypothesis therefore states:

H2: The positive effect of analytical thinking on perceived news accuracy is moderated by the complexity of the information that is portrayed in a fake news article; when complexity is high, analytical thinking will have a smaller effect on one's news accuracy ratings than when complexity is low.

Hence, it is expected that the positive relationship between engagement in analytical thinking and news accuracy ratings will be lower (or negative) under conditions of high complexity when

compared to conditions of low complexity. However, apart from the complexity of the issue that is portrayed in a fake news article it is also possible that the protective effect of analytical thinking on fake news susceptibility is moderated by one's level of involvement. Namely, the HSM indicates that high levels of involvement should increase the probability that one engages in analytical thinking. Subsequently, this engagement in the cognitive style should also increase its corrective effect on fake news susceptibility. In contrast, lower levels of involvement will make an individual more likely to refrain from analytical thinking and subsequently decrease its protective effect. Thus, the third hypothesis states:

H3: The positive effect of analytical thinking on perceived news accuracy ratings is moderated by one's level of involvement; when individuals score high on involvement, analytical thinking will have a stronger effect on one's news accuracy ratings than when involvement is low.

That is, it is expected that the positive relationship between engagement in analytical thinking and news accuracy ratings will be lower (or negative) under conditions of high involvement when compared to conditions of low involvement.

Method

Participants and design.

The study had a 2 (Analytical Thinking low vs high) by 2 (Complexity low versus high) between participants design with Perceived News Accuracy as the dependent variable and Involvement as a covariate. The study was conducted within the region of Twente in Overijssel, the Netherlands. Potential participants were approached within Twente through multiple methods, namely (1) an e-mail invitation within a large multinational retail company that reached out to all of its employees worldwide, leading to participants from a variety of different countries, levels of education, social status and an age of minimally 18 and higher, (2) a general invitation on LinkedIn, (3) by mobilizing the network of the researcher to participate themselves and engage others, (4) the 'participate in research' website of the University of Twente wherein citizens can apply to take part in a research and (4) the SONA student-database of the University of Twente wherein students participate in research in exchange for study-credits. All of the participants were approached based on their availability and willingness to participate in the study. In terms of compensation, only the students that participated in this study through SONA received a compensation in the form of a maximum of 0.25 study credits. Other participants received no compensation for their participation.

The initial sample consisted of 168 participants. Participants who failed to fully complete the survey, for which the criterion was set at a minimum of 90 % completion rate, were excluded. A percentage of 90% was chosen to keep room for a participant missing 1 or 2 questions but still having completed enough of the survey to provide valuable data. In this sense, 14 participants were excluded

because they did not fully complete the survey. Furthermore, participants that had likely speeded through the experiment were excluded as well. The criteria for this evaluation consisted of an implausibly low time spend on the experiment when compared to the median (i.e., less than 8 minutes was the cut off point) together with scoring all of the items in exactly the same way and/or scoring reverse coded items as if they were normally coded. In this sense, 6 participants were excluded because there were strong indications that they speeded through the experiment. The final sample therefore consisted of 148 participants.

The age of the final sample ranged from 19 to 87, with a mean of 39 years of age. In terms of gender, 74 participants were male, 72 participants were female, and 1 participant preferred not to say. In terms of educational level, 5 respondents had lower education (MAVO, LBO), 37 respondents had high school education (HAVO, VWO), 16 respondents had secondary vocational education (MBO) and 89 had higher education or university education (HBO, WO). In terms of nationality, 53% of participants were Dutch, 5% were American, 5% were English and 37% consisted of other nationalities. The distribution of these participants among the experimental conditions is visualized in table 1.

Table 1

Distribution of participants per experimental condition.

		Complexity		Total
		Low	High	
Analytical Thinking	Low	35	43	78
	High	35	34	69
Total		70	77	147

Procedure

The experiment was conducted by use of the online survey platform Qualtrics. Participants were firstly given the opportunity to provide informed consent, whereafter they were informed of the goal of the study, stating that the research aimed to find out what factors contribute to an individuals' ability to discern true news articles from fake news articles. Secondly, the participants were presented with two news articles that cover the topic of climate change, one of which was completely false while the other was factually accurate. The fake article was adopted from the disreputable Dutch news website 'Frontnieuws'. The article was specifically chosen because (1) the information portrayed in the article highly contradicts the mainstream climate science consensus as put forth by the International Panel on Climate Change (IPCC) and (2) the claims have been refuted by NASA (see: <https://climate.nasa.gov/explore/ask-nasa-climate/2953/there-is-no-impending-mini-ice-age/>).

In contrast, the accurate article was adopted from the Royal Netherlands Meteorological Institute (KNMI). The article was specifically chosen as it (1) was published by a reputable Dutch public

institution that specifies in forecasting and monitoring of the climate (see: <https://www.knmi.nl/over-het-knmi/about>) and (2) reflected the mainstream climate science consensus. Both articles were presented with a headline, byline, text, picture and source as this is how fake news articles are commonly disseminated to the public. After reading an article, participants were presented with a set of questions regarding the veracity of the article and their level of Involvement with the article. Lastly, the participants were asked to complete the 10-point verbal cognitive reflection test (CRT-V). The survey ended with demographic questions, which included age, gender, education, nationality and self-reported knowledge about climate science and/or climate change.

Analytical Thinking manipulation After being presented with the goal of the study, half of the participants received a manipulation message that aimed to spark Analytical Thinking while the other half of the participants received no message. The randomizer feature within Qualtrics was used and was set to balance experimental groups to ensure that the manipulation was disseminated randomly across the participants. The manipulation message specifically asked participants to think twice about the articles that they would evaluate and informed them that they would be tested on their ability to correctly identify fake news. Additionally, the guidelines used in the intervention study of Lutzke et al. (2019) were also included in the message. The guidelines reflect common recommendations for identifying fake news, and state: (1) *Do I recognize the news organization that posted the story?* (2) *Does the information in the post seem believable?;* (3) *Is the post written in a style that I expect from a professional news organization;* and (4) *Is the post politically motivated?.* In this way, the study aimed to create two conditions, being one of high Analytical Thinking and one of low Analytical Thinking, to stimulate half of the participants to think analytically and thereby assess the effect of engagement in Analytical Thinking on subsequent Perceived News Accuracy and thus test H1.

Complexity manipulation. Both of the articles were manually altered to either consist of vague scientific language and complicated figures or to consist of easy-to-understand language and illustrations. However, the main message and content of the articles were not changed. In this way, the study aimed to create two different conditions of Complexity, a high Complexity condition and a low Complexity condition, to test H2. In a similar fashion to the Analytical Thinking manipulation, the randomizer feature within Qualtrics was used and was set to balance experimental groups to ensure that the manipulation was disseminated randomly across the participants. Hence, a participant either received two easy to understand articles or two articles that were highly complex. Both articles and their respective level of Complexity can be found in appendix A.

Measures

Perceived News Accuracy. The perceived accuracy of both the fake- and real article was measured using three items on a Likert scale ranging from 1 to 5. All of the items were adopted from the studies of Roozenbeek et al (2022) and Lutzke et al. (2019). The items were: ‘on a scale of 1 to 5 and to the best of your knowledge, how accurate do you think this news article is?’ (1 being ‘very

inaccurate' and 5 being 'very accurate'), 'on a scale of 1 to 5 and to the best of your knowledge, how trustworthy do you think this news article is?' (1 being 'very untrustworthy' and 5 being 'very trustworthy') and 'On a scale of 1 to 5 and to the best of your knowledge, how manipulative do you find this news article to be?' (1 being 'not manipulative at all' and 5 being 'very manipulative'). Thus, Perceived News Accuracy was based on the mean score of all of the three items.

More importantly, separate scores were created for both the real- and fake news article. This was done because the articles differed both across the complexity conditions and in terms of their content. In addition, a participant's level of Involvement could also vary across the articles because of the difference in content. That is, a participant might be very involved with the content of the first article, but less so with the content of the second one. Therefore, in order to assess the differences in judgements of veracity across the complexity conditions of – and Involvement with – the articles it was decided to view the Perceived News Accuracy scores on both the real- and fake article as stand-alone variables rather than averaging the scores of both articles in to one central measure of Perceived News Accuracy. The scale depicted an internal consistency of Cronbach's Alpha $\alpha = 0.78$ and Lambda 2 being $\lambda = 0.78$ when participants evaluated the real news article. During the evaluation of the fake news article, the scale depicted an internal consistency of $\alpha = 0.81$ and $\lambda = 0.82$. All of the items regarding Perceived News Accuracy can be seen in appendix B.

Complexity. The Complexity manipulation was tested using 1 item on a 5-point Likert scale, namely: 'On a scale of 1 until 5, how complex or difficult in terms of language, arguments and/or content did you find this article to be?'. Participants received this question after they had evaluated an article. Thus, Complexity was measured ranging on a scale of 1 to 5 (1 being 'not complex at all and 5 being 'highly complex') per article. The scores on the accurate- and fake article were averaged into one.

An independent samples T-test was conducted to test the effectiveness of the complexity manipulation. Preliminary data screening through the use of Shapiro-Wilk tests depicted that normality for all groups at a $p < .05$ level could not be assumed. However, the independent samples T-test is deemed to be robust against violations of normality when the sample size is not below 30 participants per group (Warner, 2013). Both groups of the complexity condition were well above this number, namely 70 and 77. Furthermore, no significant outliers were identified and Levene's test for equality of variance was non-significant, $F(145) = 1.88$, $p = .17$, meaning that homogeneity of variances could be assumed. The t-test depicted a non-significant result between the experimental group and the control group, $t(145) = 1.65$, $p = .10$. Thus, the complexity manipulation was not successful.

Involvement. The level of Involvement of an individual was difficult to manipulate or trigger as it is likely based on personal variables that vary heavily between individuals and topics. In this sense, the variable was added as a covariate to test H3. To measure one's the level of Involvement, four items were used on a 5-point Likert scale. All of the items were adopted from Verroen et al. (2013) and were rewritten to fit the current study. Examples of items are: 'On a scale of 1 to 5, to what extent did you think it was important to be informed by this news article?' (1 being 'not important at all and 5 being

‘very important’) and ‘On a scale of 1 to 5, to what extent did you feel involved with the risks of climate change while reading this news article?’ (1 being ‘not involved at all’ and 5 being ‘very involved’). Thus, Involvement was based on the mean score of all of the four items.

As mentioned earlier, the articles differed both across the complexity conditions and in terms of content and therefore a participant might be very involved with the first article but less involved with the second one. Therefore, in a similar fashion to Perceived News Accuracy separate scores were also created for Involvement for both of the articles. The scale depicted an internal consistency of Cronbach’s Alpha $\alpha = 0.79$ and Lambda 2 $\lambda = 0.80$ when participants evaluated the real news article. During the evaluation of the fake news article, the scale depicted an internal consistency of $\alpha = 0.83$ and $\lambda = 0.84$. All of the items regarding Involvement can be seen in appendix C.

Analytical Thinking propensity. In addition to the manipulation message that aimed to prompt Analytical Thinking, the study also assessed one’s propensity to engage in Analytical Thinking by using the 10-item verbal cognitive reflection test (CRT-V) (Sirota et al., 2020; Sobkow et al., 2022). This specific variable should be seen as a back-up trait-variable that serves as an alternative to assess the effect of Analytical Thinking on subsequent fake news susceptibility when the manipulation message fails to work. One’s propensity to engage in Analytical Thinking was measured on a 10-point Likert scale, wherein higher scores indicate a higher tendency to engage in the cognitive style. Two examples of items from the CRT-V are: “If you have only one match and you walk into a dark room where there is an oil lamp, a newspaper and wood- which thing would you light first?” (correct answer: the match; intuitive answer: the oil lamp) and ‘The wind blows west, an electric train runs east. In which cardinal direction does the smoke from the locomotive blow?’ (correct answer: no smoke from an electric train; intuitive answer: west). More importantly, the CRT-V also consists of items that are not as well-known as original CRT items such as the baseball and the bat problem. This reduces the probability that participants already know the answers to some items which decreases the accuracy of the test.

However, during preliminary data screening it became apparent that linearity could not be assumed for CRT-V scores. Because of this, the variable was excluded from the analyses that were conducted in this study.

Demographic variables. In terms of demographics, participants were asked (1) ‘How old are you?’, (2) ‘What is your gender? (male, female, non-binary/third gender or prefer not to say), (3) ‘What is your nationality?’, (4) ‘What is the highest level of Education that you have completed?’ (lower education, high school education, secondary vocational education, higher education/university education or none) and (5) ‘ On a scale of 1 to 5, how much knowledge do you feel you possess about climate change and/or climate science’ (1 being ‘none at all’ and 5 being ‘a great deal’).

Results

Descriptives

The means, standard deviations and correlation between the variables can be seen in table 2.

Table 2

Means (M), Standard Deviations (SD), and correlation between the variables ^a

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. PNA ^b (Real Article)	3.59	0.73									
2. PNA (Fake Article)	2.22	0.83	-.24								
3. Involvement (Real Article)	3.69	0.71	.35	-.17							
4. Involvement (Fake Article)	2.75	0.91	-.13	.52	.18						
5. CRT Score	6.48	3.11	-.08	-.17	-.10	-.21					
6. Age	39.88	15.39	-.05	.21	.04	.22	-.01				
7. Gender	1.51	0.54	-.05	.14	.15	.05	-.18	.08			
8. Education	3.29	0.96	-.04	-.08	.14	.05	-.08	.20	-.07		
9. Knowledge of climate science	2.85	.71	.03	-.34	-.24	-.14	.08	-.16	.08	-.06	

Significant correlations ($\alpha < .05$) are highlighted in **bold**. Scale categories: CRT Score (1-10), other variables (1-5).

^a $N = 147$

^b PNA = Perceived News Accuracy

Some notable correlations are visible in the data. Namely, in terms of the correlation between the perceived news accuracy of the real article and the other variables, it is firstly observable that these accuracy ratings were weakly negatively correlated with the Perceived News Accuracy of the fake article, and this effect was significant, $r(145) = -.24, p < .01$. Hence, participants who rated the real article as accurate subsequently found the fake article to be less accurate. Secondly, Involvement for the real article was moderately positively correlated with perceived news accuracy for the real article, and this effect was significant as well, $r(145) = .35, p = <.001$. Thus, participants who scored high on Involvement also reported high levels of perceived news accuracy during their evaluation of the real article. Other variables were not significantly correlated with the perceived news accuracy of the real article. In terms of the correlation between the perceived news accuracy of the fake article and the other variables, it is notable that Involvement with the real article was weakly negatively correlated with the perceived news accuracy of the fake article, and this effect was significant, $r(145) = -.17, p < .05$. Thus, participants who reported higher levels of Involvement during their evaluation of the real news article

subsequently found the fake news article to be less accurate.

Furthermore, the most notable correlation that was observed in the data was that of a participants' Involvement with the fake article and the perceived news accuracy of this fake article. Namely, the effect is significant and strongly positive, $r(145) = .52, p < .001$, indicating that participants who reported higher levels of Involvement during their evaluation of the fake article also found this article to be more accurate, similarly to how high levels of Involvement with the real article led participants to report higher levels of accuracy as well. Thus, the data indicated that higher levels of involvement generally led to higher levels of accuracy for an article.

Testing the hypotheses

Two-way ANCOVA of the real article. In terms of the real article, preliminary data screening firstly revealed that no data was missing. Secondly, an evaluation of normality through Shapiro-Wilk tests revealed that normality for the residuals of all groups and perceived news accuracy at a $p < .05$ level could not be assumed. However, ANCOVA is deemed to be fairly robust to violations of normality if the number of scores in the groups are reasonably large ($N > 30$) and/or equal (Warner, 2013). In the case of this research, the latter appears to be true as group sizes were larger than 30 and fairly equal (35, 35, 34 and 43 respectively). Third, the data contained three outliers. After close inspection, no legitimate reasons to remove the univariate outliers were found, meaning that the analysis was continued without deleting or transforming any outliers. Fourth, Involvement appeared to have an approximate linear relationship with perceived news accuracy for each level of both Analytical Thinking and Complexity, indicating that linearity could be assumed. Fifth, Levene's test for equality of variance was non-significant, $F(3, 143) = 1.17, p = .32$, indicating that homogeneity of variances could be assumed. Lastly there were no significant interaction effects between both Involvement and Analytical Thinking, $F(1, 146) = 2.58, p = .11$, and Involvement and Complexity, $F(1, 146) = 1.20, p = .28$, indicating that homogeneity of regression slopes was satisfactory as well.

The two-way ANCOVA consisted of Analytical Thinking and Complexity as the independent variables, perceived news accuracy of the real article as the dependent variable and Involvement with the real article as a covariate. The relevant descriptives for the two-way ANCOVA are reported in table 3. Overall, the model depicted an adjusted R^2 of 14.5%

Firstly, Analytical thinking proved to have a significant main effect on perceived news accuracy, $F(1, 146) = 6.40, p = .01$, the estimated means of perceived news accuracy were higher for participants who were in the Analytical thinking condition when compared to those who were not in the Analytical Thinking condition ($M = 3.74, SD = 0.08$ versus $M = 3.46, SD = 0.07$), which supports hypothesis 1. Secondly, Complexity did not have a significant main effect on perceived news accuracy, $F(1, 146) = 0.81, p = .37$, which indicates that the Complexity of the article did not influence its perceived accuracy among participants. Third, there was no significant interaction effect between Analytical Thinking and Complexity on perceived news accuracy, $F(1, 146) = .09, p = .76$. Thus, the effect of Analytical Thinking

on perceived news accuracy did not differ for the different levels of Complexity which did not support hypothesis 2.

Table 3

Average perceived news accuracy ratings for the real article as a function of Analytical Thinking and Complexity while controlling for Involvement; Higher ratings indicate higher perceived accuracy of the article.

Analytical Thinking	Complexity								
	Low			High			Total		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
Low	3.58	0.70	35	3.32	0.81	43	3.45	0.75	78
High	3.81	0.58	35	3.71	0.70	34	3.76	0.64	69
Total	3.70	0.64	70	3.52	0.76	77	3.61	0.70	147

Lastly and notably, a significant relationship seemed to exist between Involvement and perceived news accuracy, $B = 0.33$; $SE = .08$, $t = 4.10$, $p < .001$. Hence, the data indicates that higher levels of Involvement subsequently led to higher levels of perceived news accuracy. This finding demonstrated the strongest effect on perceived news accuracy as well ($\eta^2_p = .11$). This apparent relationship partly supports the third hypothesis. Namely, whereas interaction between Involvement and Analytical thinking appeared to be non-significant (during the evaluation of homogeneity of regression slopes), Involvement does appear to positively affect perceived news accuracy on its own.

Two-way ANCOVA of the fake article. The second analysis consisted of the same variables as those used in the analysis of the real article, apart from perceived news accuracy and Involvement being related to the fake article instead of the real article. Preliminary data screening firstly uncovered no missing data. Secondly and similar to the real article, Shapiro-Wilk tests revealed that normality for the residuals of all groups $p < .05$ could not be assumed. However, because of the large and equal group sizes the analysis was still conducted. Third, no significant univariate outliers were detected. Fourth, Involvement again appeared to have an approximate linear relationship with perceived news accuracy for each level of Analytical Thinking and Complexity indicating that linearity could be assumed. Fifth, Levene's test for equality of variance was non-significant, $F(3, 143) = 1.22$, $p = .31$, indicating that homogeneity of variances could be assumed. Lastly, there were no significant interaction effects between both Involvement and Analytical Thinking, $F(1, 146) = .01$, $p = .94$, and Involvement and Complexity, $F(1, 146) = .13$, $p = .72$ indicating that homogeneity of regression slopes could be assumed. The relevant descriptives are reported in table 4. Overall, Overall, the model depicted an adjusted R^2 of 26.1%

Table 4

Average perceived news accuracy ratings for the fake article as a function of Analytical Thinking and Complexity while controlling for Involvement; Higher ratings indicate higher perceived accuracy of the article.

	Complexity								
	Low			High			Total		
Analytical Thinking	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>
Low	2.13	0.84	35	2.24	0.85	43	2.19	0.46	78
High	2.20	0.77	35	2.30	0.80	34	2.25	0.79	69
Total	2.17	0.81	70	2.27	0.83	77	2.22	0.64	147

Firstly and contrary to the real article, it appeared that Analytical Thinking did not have a significant main effect on Perceived news accuracy, $F(1, 146) = .89, p = .35$. Therefore, hypothesis 1 was rejected as the Analytical Thinking manipulation did not cause participants to significantly rate the fake article as inaccurate. Secondly and similarly to the real article, Complexity did not have a significant effect on perceived news accuracy, $F(1, 146) = 1.67, p = .20$. Thus, the Complexity of the article did not influence its subsequent perceived news accuracy among participants. Third, there was no significant interaction effect between Analytical Thinking and Complexity on perceived news accuracy, $F(1, 146) = 0.40, p = .84$. Hence, the effect of Analytical Thinking on perceived news accuracy did not differ for the different levels of Complexity for the fake article as well. Therefore, hypothesis 2 was rejected.

Most notably and similarly to the real article, there was a significant relationship between Involvement and perceived news accuracy, ($B = 0.48; t = 7.377, p = <.001$), and this finding also demonstrated the strongest effect on the dependent variable ($\eta^2p = .28$) Hence, the higher Involvement was, the higher was perceived news accuracy. Thus, Involvement again positively affected perceived news accuracy on its own while an interaction effect between Involvement and Analytical Thinking appeared to be non-significant. Ultimately, hypothesis 3 was rejected as Involvement did not appear to moderate the effect of the Analytical Thinking. However, it was notable that Involvement consistently proved to have the strongest, positive relationship with perceived news accuracy across the two articles.

Discussion and conclusion

The central question that was asked in this study was: *'In what way do complexity and level of involvement influence the reducing effect of analytical thinking on fake news susceptibility?'*

In general, this study was unable to demonstrate that analytical thinking has a reducing effect on an individuals' susceptibility to fake news in the first place, but it did show that this effect differed across the two articles. In addition, the hypothesized effect of analytical thinking on fake news susceptibility

was not moderated by either the complexity of a (fake) news article or the level of involvement that an individual has while reading a (fake) news article. Hence, all of the three hypotheses were rejected, leading to the conclusion that analytical thinking did not significantly lower fake news susceptibility and that both complexity and involvement did not influence the hypothesized protective effect of the cognitive style.

However, involvement did appear to be the strongest predictor of an individuals' fake news susceptibility as higher levels of involvement seemingly led to higher accuracy ratings for both the real article and the fake article. This proved to be the most remarkable finding in this study. Namely, whereas the HSM mainly suggests that higher levels of involvement will lead to a higher intention to engage in analytical thinking and thus an increase of its protective effect against fake news, the results of this study indicate that involvement instead increases fake news susceptibility. However, while the results have important implications for both theory and practice, they should be carefully interpreted as the statistical power observed in this study was rather low. An elaboration will be given per rejected hypothesis, followed up by the main conclusion of the study. Thereafter, practical implications, limitations and avenues for future research will be discussed.

Analytical Thinking did not reduce fake news susceptibility.

Engagement in analytical thinking only caused participants to rate the real article as significantly more accurate whereas no effect was observed for the fake article. That is, even though participants rightfully found the real article to be accurate and the fake article to be inaccurate based on the means of perceived news accuracy, there was no significant reduction in the perceived accuracy of the fake article by those who were deemed to be engaging in analytical thinking within this specific study. This finding contradicts the classical reasoning account as its main premise suggests that engagement in analytical thinking would protect an individual against fake news. Because of this, this study seemingly adheres to the aforementioned claims of scholars about the questionable effectiveness of analytical thinking in the context of fake news. Namely, evaluations of interventions that aimed to nudge accuracy resulted in mixed findings (Pennycook et al., 2020; Lutzke et al., 2019; van der Linden, 2022) and other research found that highly analytical individuals can still be susceptible to fake news because of their underlying partisanship (Roozenbeek et al., 2022; Gawronski, 2022). Therefore, it generally appears that engagement in analytical thinking again fails to display its promised effect and that the classical reasoning accounts' claim about the cognitive style should not be taken for granted.

However, a possible reason for the absence of the hypothesized effect is that this study failed to sufficiently trigger its participants to engage in analytical thinking. That is, even though the manipulation was significant the effect might not have been strong enough. Hence, only one manipulation message was used to spark engagement in analytical thinking among those who received it. It could be that participants skipped the manipulation message and/or did not sufficiently read it, making it that one could only guess whether they truly engaged in analytical thinking. Additionally, previous work on these

accuracy nudges already demonstrated that these types of interventions usually lead to small effects based on much larger sample sizes than that of the sample used within this study (Lutzke et al., 2019; Roozenbeek et al., 2021). In this sense, the sample size of this study could have not been sufficient enough to find a significant effect of analytical thinking. The CRT-V was used to give an extra indication of one's propensity to engage in analytical thinking. Notably, there was a small and significant negative correlation between these scores and the perceived news accuracy of the fake article which suggested that higher propensity to engage in analytical thinking did lead to lower fake news susceptibility. However, as mentioned earlier it appeared that these scores were not usable in the analyses due to non-linearity and therefore this effect could not be properly tested.

Still, suboptimalities in the sample and design of this study do not have to be the reason for the absence of the hypothesized effect as there were already questions about the effectiveness of analytical thinking. Nonetheless, it does appear that participants who were in the analytical thinking condition rated the real article as significantly more accurate. Thus, engagement in analytical thinking had no effect for one article, but it did have an effect for another, different article. The latter seemingly suggests that there are indeed instances wherein analytical thinking is either more or less effective, a question that was posed by Faragó et al. (2023), van der Linden (2022) and Pennycook and Rand (2019) and served as the starting point for this study.

In fact, it could well be that the manipulation message steered participants to focus their interest on particular aspects of the articles that they were evaluating. That is, the guidelines in the message informed participants that an article should be published by a recognizable news organization. Therefore, the source of the article received particularly more attention by those who received the manipulation message and because the KNMI (the publisher of the accurate article) is categorized as an official institute of science within the Netherlands it could have led to increased accuracy ratings for this article. Especially as the publisher of the second article, Frontnieuws, is not categorized as an official institute. There is already some evidence stating that the source of an article has an effect on fake news susceptibility (Pennycook & Rand, 2020; van der Linden, 2022; Ecker et al., 2022).

Therefore, even though the hypothesized instances that were investigated in this study (i.e. complexity and involvement) did not appear to influence the hypothesized protective effect of Analytical Thinking, this finding indicates that uncovering the instances that either increase or decrease the effect of analytical thinking on fake news susceptibility still proves to be an important avenue for future research by for instance focusing more on the source of the article in relation to the effect of analytical thinking.

Complexity did not influence Analytical Thinking.

It was theorized that the perceived Complexity of an article would influence the protective effect of analytical thinking on fake news susceptibility, making it less effective. That is, when an article consists of highly complex language it is likely that analytical thinking will provide limited protection

for those who do not possess the required knowledge and/or skills needed to understand the information that is presented. However, the complexity manipulation did not significantly increase the perceived complexity of the articles and there was no significant interaction between engagement in analytical thinking and complexity. Hence, this study could not demonstrate that content that is perceived as highly complex causes highly analytical individuals to be less able to detect fake news articles. Thus, complexity does not seem to be an instance wherein the protective effect of analytical thinking is reduced (or increased).

There is, however, a possible reason for the absence of the hypothesized effect. Namely, the mean scores of complexity did not vary heavily between the experimental group and the control group. This indicates that next to the fact that the complexity manipulation was unsuccessful in causing participants in the high complexity condition to perceive the articles as significantly more complex, it could not create a strong difference in perceived complexity amongst the two groups as well. Because of the absence of such a spread between the groups, it is hard to say whether the complexity manipulation truly provided participants with articles that they really struggled with and therefore affected their accuracy judgements. This could also explain the absence of a significant main effect of complexity on perceived news accuracy. It is, however, difficult to create an experimental condition that consists of articles which every individual will find very complex as this will likely vary heavily between individuals. That is, what is difficult to understand for one person will be very easy to understand for another based on interpersonal differences in for instance prior knowledge and intelligence.

Still, the data indicates that the complexity of an article seemingly has no effect on the relationship between analytical thinking and fake news susceptibility. This insight further extends the classical reasoning account by adding that the complexity of an article does not seem to influence the hypothesized protective effect of analytical thinking on one's fake news susceptibility. Moreover, it also adds to the theoretical debate on the psychological predictors of fake news susceptibility as the complexity of a (fake) news article is seemingly not a factor that one should worry about. The same was true for one's level of involvement, but this factor did have a remarkable effect on its own.

The effect of Involvement on Analytical Thinking

According to the HSM, higher levels of personal involvement with an issue should lead to an increase in one's propensity to engage in analytical thinking. Subsequently, this higher intention to engage in analytical thinking should increase the hypothesized protective effect of the cognitive style on one's fake news susceptibility. However, this study could not demonstrate that the latter is plausible as no significant interaction was apparent between engagement in analytical thinking and level of involvement while checking for the homogeneity of regression slopes during both analyses. Hence, this study gave no indication that one's level of involvement influences the hypothesized effect of analytical thinking on subsequent fake news susceptibility. Thus, one's level of involvement does not seem to be a moderator of the hypothesized protective effect of analytical thinking.

A possible explanation for the absence of this effect could be that involvement with an article does not adequately motivate an individual to engage in analytical thinking. Namely, there have been criticisms on the method to determine involvement, as the expectation of receiving a gift for correct recall of a product was meant to indicate that a participant was highly involved (Cyr et al., 2018). Basing involvement only on the expectation of receiving a gift is questionable, as there could have well been other factors that motivated an individual to engage in analytical thinking. Hence, highly involved participants in this study could still not have been motivated to engage in analytical thinking which would explain the absence of an interaction. Additionally, the HSM also adds the importance of ability. Namely, it is suggested that both high involvement and/or ability can cause an individual to engage in analytical thinking. In fact, it could be that ability serves as a prerequisite for an individual to engage in analytical thinking as well as for analytical thinking to protect an individual against fake news. When applying the latter to this study, it appeared that the mean of knowledge of climate science was below the midpoint of its scale. Hence, participants generally did not have a lot of knowledge about climate science, indicating a general lack of ability. Subsequently, this lack of ability could have been the cause for the absence of an effect of involvement on the hypothesized protective effect of analytical thinking as it caused individuals to refrain from thinking deliberately about the articles regardless of having a high level of involvement with these articles. Notably, knowledge of climate science was negatively correlated with the perceived news accuracy of the fake article and the real article. This might indicate that highly informed participants refrained from thinking analytically because they felt less involved and motivated because of their expertise, or in more simple terms because ‘they already knew’.

Still, because a significant interaction between involvement and analytical thinking was not apparent it seemed that the effect of analytical thinking on perceived news accuracy did not differ for different levels of involvement in this specific study. Hence and similar to complexity, this finding further extends both the classical reasoning account by adding that certain levels of involvement do not seem to be an instance wherein the protective effect of analytical thinking is either increased or reduced. However, and more importantly, involvement did affect one’s perceived news accuracy on its own.

Involvement seemingly increases fake news susceptibility

The data depicted that higher levels of involvement led to a significant increase in the perceived news accuracy of an article, but notably this accounted for both the real article and the fake article. This finding is remarkable as higher levels of involvement should have led to a higher intention to engage in analytical thinking and a subsequent protective effect against fake news. However, high levels of involvement also increased the perceived news accuracy of the fake article. Hence, it seems that higher levels of involvement with a topic tend to increase the perceived accuracy of a certain piece of information which covers that topic.

A possible explanation for this phenomenon can be derived from the fact that the HSM does not dictate the extent to which individuals may still rely on heuristic processing - a processing mode that

according to the classical reasoning account will cause individuals to fall for fake news - when involvement and ability are high (Ali et al., 2022; Koch et al., 2023). In this sense, it could be that while higher levels of involvement caused a participant to engage in deliberative reasoning about an article, he or she could simultaneously have relied on heuristic processing as well. Because of this, heuristic biases could still affect one's reasoning processes and therefore make an individual more susceptible to fake news. More importantly, it could be that higher levels of involvement actually increase the salience of these biases. For example, an individual who strongly believes that climate change is not caused by humans may think very deliberately about a fake article that enforces this statement because of his involvement with the topic. However, because of these high levels of involvement, it could be that his or her bias, i.e. a mistaken belief that climate change is not caused by humans, might also become more salient and therefore cause him or her to still claim that article is accurate. Notably, the latter seemingly adheres to the main premise of the motivated reasoning account of fake news susceptibility.

Namely, the motivated reasoning account argues that pre-existing values, beliefs, goals, and affinities to social groups can influence cognitive processes in such a way that an individual will start out their reasoning process with a pre-determined goal and subsequently interpret information in the service of this goal. Hence, higher levels of involvement could have made such pre-existing values, beliefs, goals and affinities to social groups salient, influencing their deliberative reasoning processes and causing him or her to find the information more credible. This is however up for debate as such pre-existing values and biases were not directly assessed within this study, making it difficult to claim their possible influence. However, involvement did significantly predict higher levels of perceived accuracy for the fake article, indicating that it could be an important predictor of fake news susceptibility. Hence, the latter proves to a phenomenon that should be studied further.

Conclusion

It appears that analytical thinking did not have a reducing effect on fake news susceptibility. Hence, the results of this study indicate that analytical thinking does not protect individuals from fake news which contradicts the claims of the classical reasoning account and adheres to earlier claims about the questionable effectiveness of the cognitive style. In addition, two possible factors that could have either increased or reduced the protective effect of the cognitive style, namely the complexity of an article and one's involvement with an article, do not seem to affect the relationship between analytical thinking and fake news susceptibility. Hence, more work is still needed to uncover which factors most strongly determine that an individual will fall for the deceptive contents of fake news articles. A promising example of such work is the so-called integrative account of fake news susceptibility put forth by van Bavel and Pereira (2021) and Van der Linden (2022). This account incorporates both identity-related factors (i.e., the motivated reasoning account) and cognitive factors (i.e., the classical reasoning account) and demonstrated the most predictive power in a recent comparison of models that aimed to predict fake news susceptibility (Borukhson et al., 2022). Hence, it seems that a holistic approach

towards psychological determinants of fake news susceptibility will be the best avenue for future research. Moreover, this study provides strong evidence that one's level of involvement with a certain article is a determinant that should be incorporated in these future research projects. Namely, higher levels of involvement increased the perceived accuracy of an article regardless of whether it was true or not and therefore proves to be a phenomenon that should be investigated further.

Practical implications

The main result of this study indicates that analytical thinking did not significantly reduce one's susceptibility to fake news. Because of this, it is questionable whether interventions that aim to nudge engagement in analytical thinking among individuals will be the right method in the battle against disinformation. Namely, this study indicates that only one's level of involvement with a certain issue can cause individuals to fall for a fake news. Therefore, those that want to reduce the negative effects of false information should shift their initiatives to be more focused the role of involvement. Concrete examples of such initiatives could be an informational campaign which aims to inform the public that being very involved with a certain issue can also create a bias which makes them more susceptible to false information. Being aware of the possibility of this bias could protect individuals against future encounters with fake news. In addition, teaching individuals how they can still detect fake news regardless of being very involved with a certain topic should further reduce the negative effects of the deceptive information.

Another example is to expand the fact-checking labels that can for instance be seen on both Twitter and Facebook. Namely, articles that are proven to be fake often get a label that notifies its reader about its manipulative contents. However, these labels should also include a brief description on how an article might try to exploit an individual's gut feeling in order to make it more believable. Additionally, such a label could also describe how being very involved with the issue could make it more believable as well even though it is not a factual piece of information. Hence, reminding an individual of the possibility of this effect when they are confronted with provenly false information should make them more hesitant in believing a fake news article.

Limitations

First and foremost, this study experienced poor statistical power. Namely, the sample size was rather low, the data was not normally distributed and there were three outliers that were not removed during the analyses of the real article. Therefore, if the dataset did not consist of any outliers and if statistical power was sufficiently high, one could argue that the results of the analyses would be more trustworthy. The latter is especially true as earlier research designs which tried to trigger engagement in Analytical Thinking required much larger sample sizes to uncover significant effects. Hence, as mentioned in the discussion of this study it is important to state that the result should be interpreted with caution and future research projects should retest the hypotheses in this study based on larger, normally distributed sample sizes.

Secondly, this study only made use of two articles to assess whether participants would detect a fake news article. Having only one article that is fake does not immediately suggest that individuals were either good or bad at detecting fake news as it is entirely possible that even the most analytical and knowledgeable individuals can still make a mistake and thus rate a fake article as accurate. Hence, by including more articles, and thus more opportunities to correctly spot false articles, in future research projects the assessment of one's ability to correctly identify fake articles will be more reliable. In fact, other research that did make use of more articles, mostly in the form of a set of headlines, did find that Analytical Thinking caused individuals to be better at discerning truth from lies (Pennycook & Rand, 2021; Faragó et al, 2023; Lutzke et al., 2019).

Third, the articles used within this study only consisted of issues regarding the danger of climate change. Even though this issue and the underlying climate science can be seen as highly complex in nature, there are of course different topics that could have been equally complex, or even more complex. For example, this study did not assess whether perceived complexity affects the hypothesized protective effect of analytical thinking when an article described the complex medical science behind COVID-19 vaccination, a topic known for being surrounded by a widespread of disinformation. Hence, future research should include a set of articles that consists of multiple complex issues and topics. The latter might further develop our understanding of the role of Complexity regarding fake news susceptibility across different domains of expertise.

Avenues for future research

First and foremost, the most notable finding in this study consisted of the fact that involvement had a significant relationship with perceived news accuracy. Namely, higher levels of involvement led to higher levels of the perceived accuracy of an article. Hence, future research should focus on investigating why higher levels of involvement apparently increase the credibility of certain information.

Secondly, even though this study was unable to demonstrate that analytical thinking has a reducing effect on an individuals' susceptibility to fake news, it did appear that the cognitive style had a significant effect on the real article. Thus, engagement in analytical thinking had no effect for one article, but it did have an effect for another, different article. Hence, apart from complexity and involvement, there are seemingly still instances wherein analytical thinking is either more or less effective, indicating that more work is needed to uncover what these exact instances are. Examples of such instances are for example relevant prior knowledge and literary skills as they both proved to be important factors regarding fake news susceptibility (Pennycook & Rand, 2021; Beauvais, 2022; van der Linden, 2022) and could possibly affect the effectiveness of deliberate reasoning processes.

Lastly, the means of perceived complexity indicated that that participant rated the fake article as more accurate when complexity was high. In contrast, participants tended to rate the real article as less accurate under conditions of high complexity. Hence, even though no significant effect of complexity was found in this study it does appear that it can influence the perceived accuracy of a news

article. Because of this, future research on this phenomenon through investigate why difference was apparent as well as further deepen the knowledge on the role of complexity regarding fake news susceptibility.

References

- Aisch, G., Huang, J. & Kang, C. (2016) Dissecting the #PizzaGate Conspiracy Theories. *NYtimes*.
<https://www.nytimes.com/interactive/2016/12/10/business/media/pizzagate.html>
- Beauvais, C. (2022). Fake news: Why do we believe it? *Joint Bone Spine*, 89(4), 1-6
<https://doi.org/10.1016/j.jbspin.2022.105371> <https://doi.org/10.1111/ajpy.12233>
- Borukhson, D., Lorenz-Spreen, P. & Ragni, M. (2022). When Does an Individual Accept Misinformation? An Extended Investigation Through Cognitive Modeling. *Computational Brain & Behaviour*, 5, 244-260. <https://doi.org/10.1007/s42113-022-00136-3y>
- Baptista, P.J. & Gradim, A. (2022). Who Believes in Fake News? Identification of Political (A)Symmetries. *Social Sciences*, 11(10), 1-13. <https://doi.org/10.3390/socsci11100460>
- Cyr, D., Head, M., Lim, E. & Stibe, A. (2018). Using the elaboration likelihood model to examine online persuasion through website design. *Information & Management*, 55(7), 807-821.
<https://doi.org/10.1016/j.im.2018.03.009>
- Diehl, T., & Lee, S. (2022). Testing the cognitive involvement hypothesis on social media: “News finds me” perceptions, partisanship, and fake news credibility. *Computers in Human Behavior*, 128, 1-10. <https://doi.org/10.1016/j.chb.2021.107121>
- Druckman, J. N., & McGrath, M. C. (2019). The evidence for motivated reasoning in climate change preference formation. In *Nature Climate Change*, 9(2), 111–119. <https://doi.org/10.1038/s41558-018-0360-1>
- Ecker, U. K. H., Lewandowsky, S., Cook, J., Schmid, P., Fazio, L. K., Brashier, N., Kendeou, P., Vraga, E. K., & Amazeen, M. A. (2022). The psychological drivers of misinformation belief and its resistance to correction. *Nature Reviews Psychology*, 1(1), 13–29.
<https://doi.org/10.1038/s44159-021-00006-y>
- European Commission. (2018). A multi-dimensional approach to disinformation.
<https://op.europa.eu/en/publication-detail/-/publication/6ef4df8b-4cea-11e8-be1d-01aa75ed71a1/language-en>
- Evans, J.St.B.T. (2003). In two minds: dual-process accounts of reasoning. *TRENDS in cognitive sciences*, 7(10), 454-509. <https://doi.org/10.1016/j.tics.2003.08.012>
- Evans, J.St.B.T. & Stanovich, K.E. (2013). Dual-Process Theories of Higher Cognition: Advancing the Debate. *Perspectives on Psychological Science*, 8(3), 223-241.
<https://doi.org/10.1177/1745691612460685>

- Erlich, A., Garner, C., Pennycook, G. & Rand, D.G. (2023). Does Analytic Thinking Insulate Against Pro-Kremlin Disinformation? Evidence From Ukraine. *Political Psychology*, 44(1), 79-94. <https://doi.org/10.1111/pops.12819>
- Faragó, L., Krekó, P. & Orosz, G. (2023). Hungarian, lazy, and biased: the role of analytic thinking and partisanship in fake news discernment on a Hungarian representative sample. *Nature Scientific Reports*, 13(178), 1-9.
- Gawronski, B. (2021). Partisan bias in the identification of fake news. *Trends in Cognitive Sciences*, 25(9), 723-724. <https://doi.org/10.1016/j.tics.2021.05.001>
- Jackman, T. (2021). Police union says 140 officers injured in Capitol riot. *The Washington Post*. https://www.washingtonpost.com/local/public-safety/police-union-says-140-officers-injured-in-capitol-riot/2021/01/27/60743642-60e2-11eb-9430-e7c77b5b0297_story.html
- Kantorowicz-Reznichenko, E., Folmer, C. R., & Kantorowicz, J. (2022). Don't believe it! A global perspective on cognitive reflection and conspiracy theories about COVID-19 pandemic. *Personality and Individual Differences*, 194, 1-8. <https://doi.org/10.1016/j.paid.2022.111666>
- Kahneman, D. (2011). *Thinking, fast and slow*. Penguin Books.
- Lutzke, L., Drummond, C., Slovic, P. & Árvai, J. (2019). Priming critical thinking: Simple interventions limit the influence of fake news about climate change on Facebook. *Global Environmental Change*, 58, 1-10. <https://doi.org/10.1016/j.gloenvcha.2019.101964>
- Koch, T.K., Frischlich, L. & Lerner, E. (2023). Effects of fact-checking warning labels and social endorsement cues on climate change fake news credibility and engagement on social media. *Journal of Applied Social Psychology*, 1-13. DOI: 10.1111/jasp.12959
- MacFarlane, D., Hurlstone, M. J., & Ecker, U. K. H. (2020). Protecting consumers from fraudulent health claims: A taxonomy of psychological drivers, interventions, barriers, and treatments. *Social Science and Medicine*, 259, 1-15. <https://doi.org/10.1016/j.socscimed.2020.112790>
- Mirhoseini, M., Early, S., El Shamy, N. & Hassanein, K. (2023). Actively open-minded thinking is key to combating fake news: A multimethod study. *Information & Management*, 60(3), 1-12. <https://doi.org/10.1016/j.im.2023.103761>
- Nichols, C. (2021). Can You Handle The Truth?: How Misinformation Fueled The January 6 Capitol Insurrection. *Capradio*. <https://www.capradio.org/articles/2021/07/09/can-you-handle-the-truth-how-misinformation-fueled-the-january-6-capitol-insurrection/>

- Pennycook, G., & Rand, D. G. (2019). Lazy, not biased: Susceptibility to partisan fake news is better explained by lack of reasoning than by motivated reasoning. *Cognition*, *188*, 39–50. <https://doi.org/10.1016/j.cognition.2018.06.011>
- Pennycook, G., McPhetres, J., Zhang, Y., Lu, J.G. & Rand, D.G. (2020). Fighting COVID-19 Misinformation on Social Media: Experimental Evidence for a Scalable Accuracy-Nudge Intervention. *Psychological Science*, *31*(7), 770-780. <https://doi.org/10.1177/0956797620939054>
- Pennycook, G., & Rand, D. G. (2021). The Psychology of Fake News. *Trends in Cognitive Sciences*, *25*(5), 388–402). <https://doi.org/10.1016/j.tics.2021.02.007>
- Pereira, A., Harris, E. & Van Bavel, J.J. (2021). Identity concerns drive belief: The impact of partisan identity on the belief and dissemination of true and false news. *Group Processes & Intergroup Relations*, *26*(1), 1-24. DOI: 10.1177/13684302211030004
- Roozenbeek, J., Maertens, R., Herzog, S. M., Geers, M., Kurvers, R., Mubashir, & van der Linden, S. (2022). Susceptibility to misinformation is consistent across question framings and response modes and better explained by myside bias and partisanship than analytical thinking Susceptibility to misinformation. *Judgment and Decision Making*, *17*(3), 547-573. <https://journal.sjdm.org/22/220228/jdm220228.pdf>
- Roozenbeek, J., Freeman, A.L.J. & van der Linden, S. (2021). How Accurate Are Accuracy-Nudge Interventions? A Preregistered Direct Replication of Pennycook et al. (2020). *Psychological Science*, *32*(7), 1169-1178. <https://doi.org/10.1177/09567976211024535>
- Swami, V., Voracek, M., Stieger, S., Tran, U.S. & Furnham, A. (2014). Analytic thinking reduces belief in conspiracy theories. *Cognition*, *133*(3), 572-585. <https://doi.org/10.1016/j.cognition.2014.08.006>
- Szebeni, Z., Lönnqvist, J.E. & Jasinskaja-Lahti, I. (2021). Social Psychological Predictors of Belief in Fake News in the Run-Up to the 2019 Hungarian elections: The Importance of Conspiracy Mentality supports the Notion of Ideological Symmetry in Fake News Belief. *Frontiers in Psychology*, *12*, 1-17. doi: 10.3389/fpsyg.2021.790848
- Sirota, M., Dewberry, C., Juanchich, M., Valus, L. & Marshall, A.C. (2020). Measuring cognitive reflection without the maths: Development and validation of the verbal cognitive reflection test. *Journal of Behavioral Decision Making*, *34*(3), 322-343. <https://doi.org/10.1002/bdm.2213>
- Sobkow, A., Olszewska, A. & Sirota, M. (2022). The factor structure of cognitive reflection, numeracy, and fluid intelligence: The evidence from the Polish adaptation of the Verbal CRT. *Journal of Behavioral Decision Making*, *36*(2), DOI: 10.1002/bdm.2297

- Tandoc, E. C. (2019). The facts of fake news: A research review. *Sociology Compass*, 13(9), 1-9.
<https://doi.org/10.1111/soc4.12724>
- van Bavel, J. J., & Pereira, A. (2018). The Partisan Brain: An Identity-Based Model of Political Belief. *Trends in Cognitive Sciences*, 22(3), 213–224. <https://doi.org/10.1016/j.tics.2018.01.004>
- van der Linden, S. (2022). Misinformation: susceptibility, spread, and interventions to immunize the public. *Nature Medicine*, 28(3), 460–467.
<https://doi.org/10.1038/s41591-022-01713-6>
- van der Linden, S., Leiserowitz, A. & Maibach, E.W. (2018). Scientific agreement can neutralize politicization of facts. *Nature human behaviour*, 2, 2-3. <https://doi.org/10.1038/s41562-017-0259-2>.
- Verroen, S., Gutteling, J.M. & De Vries, P.W. (2013). Enhancing Self-Protective Behavior: Efficacy Beliefs and Peer Feedback in Risk Communication. *Risk Analysis*, 33(7), 1252-1264.
- Wendling, M. (2016). The saga of ‘Pizzagate’: The fake story that shows how conspiracy theories spread. *BBC*. <https://www.bbc.com/news/blogs-trending-38156985>
- Warner, R.M. (2013). *Applied Statistics, From Bivariate Through Multivariate Techniques*. Sage Publications Inc.
- Young, J. C. (2021). Disinformation as the weaponization of cruel optimism: A critical intervention in misinformation studies. *Emotion, Space and Society*, 38, 1-7.
<https://doi.org/10.1016/j.emospa.2020.100757>

APPENDIX A: News articles used in the study

Article 1 | REAL | LOW COMPLEXITY Link to original article: <https://www.knmi.nl/over-het-knmi/nieuws/ipcc-menselijke-beïnvloeding-van-het-klimaatstelsel-vaststaand-feit-1-5-graden-grens-tien-jaar-eerder-bereikt-dan-verwacht>)



IPCC: Human influence on the climate system established fact, 1.5 °C limit reached 10 years earlier than expected

9th of august, 2021

Rapid climate changes have taken place in all areas of the world, which is reflected in an increase in weather extremes. The average temperature (worldwide) has increased to 1.1°C (0.8°C to 1.3°C) in the last decade compared to the pre-industrial period of 1850-1900. The rate of global warming is unparalleled in at least the last two thousand years. Some changes will be irreversible in the coming centuries to millennia, such as the warming of the oceans, the melting of the ice caps and the rise in sea levels. With a further increase in temperature, the number of heat waves, extreme rainfall and drought will increase and become more intense. This also increases the risk of exceeding certain limits in the climate system (such as CO₂ emissions and temperature in degrees Celsius), resulting in abrupt and irreversible climate changes.

Since the previous Intergovernmental Panel on Climate Change (IPCC) report in 2013, much progress has been made in terms of knowledge and understanding of the climate system. For example, climate sensitivity can now be determined more precisely. The climate sensitivity indicates what the global temperature rise will be if the CO₂ concentration in the air doubles. The likely limits of that climate sensitivity have now been set at between 2.5°C and 4°C with a best estimate of 3°C. This is more precise than in the previous IPCC report (1.5°C to 4.5°C).

Human influence

The influence of humans on the observed temperature rise has also been mapped out much better in this report. The increase in greenhouse gases in the atmosphere since the pre-industrial era (1850s-

1900s) is already responsible for a warming of 1°C to 2°C. This effect is partly masked (by 0°C to 0.8°C) by the cooling effect of aerosols (small dust particles). The observed increase in temperature can therefore be attributed entirely to human influence.

1.5 degree limit

In all IPCC emission scenarios, the 1.5 degree temperature rise will be reached in about ten years, a decade earlier than expected. This temperature limit is an important psychological barrier due to the Paris Climate Agreement concluded in 2015, which aims to limit the temperature increase to well below 2, and preferably to 1.5 degrees. Deep reductions in CO₂ and other greenhouse gas emissions will be needed in the coming decades in order not to exceed the Paris temperature limits in this century. The new timing of reaching 1.5 degrees of warming is explained by a revised estimate of historical warming and a faster rise in temperatures since the previous IPCC report. The remaining carbon budget for 1.5 degrees is 400 gigatons of CO₂ and for 2 degrees 1150 gigatons of CO₂ (in line with the latest estimate from the IPCC 1.5 degrees report). Emissions in 2019 amounted to 43 Gigatons of CO₂ per year. If the remaining carbon budget is exceeded, the temperature rise can only be reduced again with negative emissions.

Sea level rise

The expected global average sea level rise has increased compared to the previous IPCC report: in a scenario with low greenhouse gas emissions this is 28 to 55 centimeters and with high emissions it is 63 to 101 centimeters in 2100, compared to 1995-2014. Exceeding sea level rise of 2 meters in 2100 and 5 meters in 2150 cannot be ruled out if the Antarctic ice melt accelerates in the highest emission scenario.

Approved

The summary for policymakers of the sixth IPCC report on the physical basis of the climate system was approved on August 6, 2021, in a two-week virtual meeting by the country delegations of the United Nations Climate Panel. This also adopts the underlying main report.

Climate signal'21

In October, the KNMI will publish a first interpretation of this report for the Netherlands. This knowledge has been supplemented with observations and research by the KNMI. The Climate Signal'21 shows the state of the climate in the Netherlands.

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Article 1 | REAL | HIGH COMPLEXITY



A IPCC: Human influence on climate system is an established fact, 1.5 °C limit reached 10 years earlier than expected.

9th of august, 2021

Rapid climate changes have taken place in all regions of the world, manifesting themselves in an increase in weather extremes. The global average temperature has increased to 1.1°C (0.8°C to 1.3°C) in the last decade compared to the pre-industrial period 1850-1900. The rate of global warming is unparalleled in at least the last 2,000 years. Some changes will be irreversible in the coming centuries to millennia, such as the warming of the oceans, the melting of the ice caps and the rise in sea levels. With a further increase in temperature, the frequency and intensity of heat waves, extreme precipitation and drought will increase. The risk of exceeding certain physical threshold values in the climate system, resulting in abrupt and irreversible climate changes, will then also increase.

Since the previous Intergovernmental Panel on Climate Change (IPCC) report in 2013, much progress has been made in terms of knowledge and understanding of the climate system. For example, there are now techniques to attribute impacts formally to anthropogenic global warming and associated rainfall change while taking into account other drivers such as land-use change and pollution (e.g., tropospheric ozone). There are multiple lines of evidence that climate change has observable and often severely negative effects on people, especially where climate-sensitive biophysical conditions and socio-economic and political constraints on adaptive capacities combine to create high vulnerabilities.

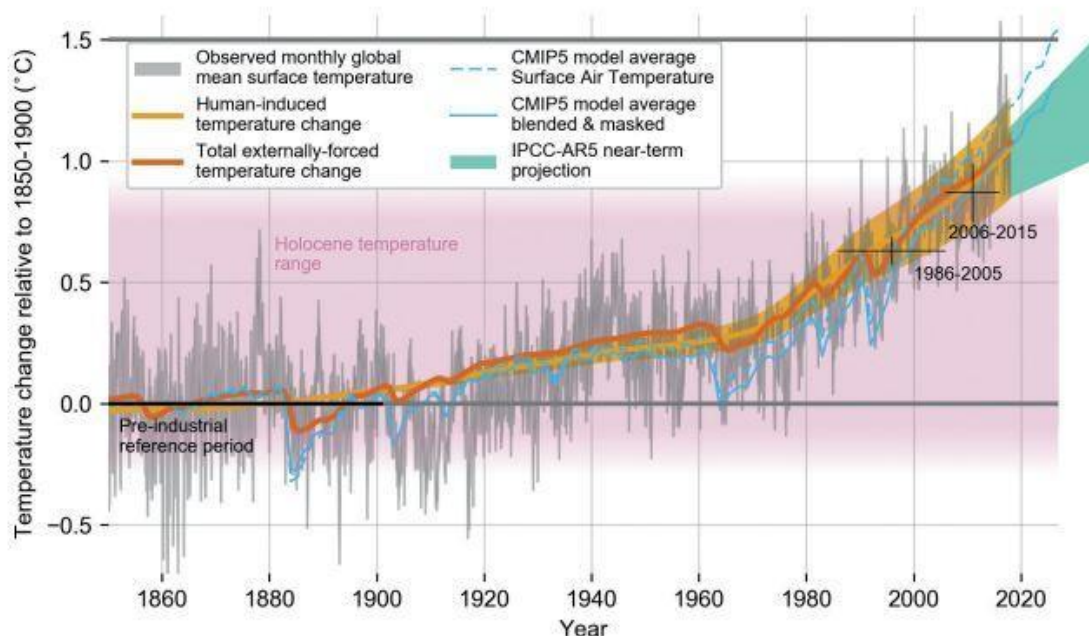
Human influence

Human influence on climate has been the dominant cause of observed warming since the mid-20th century, while global average surface temperature warmed by 0.85°C between 1880 and 2012, as reported in the IPCC Fifth Assessment Report, or AR5. The increase in greenhouse gases in the atmosphere since the pre-industrial era (1850s-1900s) is already responsible for a warming of 1°C to 2°C. The observed increase in temperature can be attributed entirely to human influence. Temperature rise to date has already resulted in profound alterations to human and natural systems, including

increases in droughts, floods, and some other types of extreme weather; sea level rise; and biodiversity loss – these changes are causing unprecedented risks to vulnerable persons and populations

1.5 degree limit

In all IPCC emission scenarios, the 1.5 degree temperature rise will be reached in about ten years, a decade earlier than expected (see the graph below).



Deep reductions in CO₂ and other greenhouse gas emissions will be needed in the coming decades in order not to exceed the Paris temperature limits in this century. Several approaches have been proposed to estimate carbon budgets compatible with 1.5°C or 2°C. Most of these approaches indirectly rely on the approximate linear relationship between peak global mean temperature and cumulative emissions of carbon (the transient climate response to cumulative emissions of carbon, TCRE) whereas others base their estimates on equilibrium climate sensitivity. The remaining carbon budget for 1.5 degrees is 400 gigatons of CO₂ (with 67 percent certainty) and for 2 degrees 1150 gigatons of CO₂ (in line with the latest estimate from the IPCC 1.5 degrees report). Emissions in 2019 amounted to 43 GtCO₂ per year. If the remaining carbon budget is exceeded, the temperature rise can only be reduced again with negative emissions.

Sea level rise

Global mean sea level rise (GMSLR) is projected to be around 0.1 m (0.04 – 0.16 m) less by the end of the 21st century in a 1.5°C warmer world compared to a 2°C warmer world (medium confidence). Projected GMSLR for 1.5°C of global warming has an indicative range of 0.26 – 0.77m, relative to 1986–2005, (medium confidence). A smaller sea level rise could mean that up to 10.4 million fewer people (based on the 2010 global population and assuming no adaptation) would be exposed to the impacts of sea level rise globally in 2100 at 1.5°C compared to at 2°C

Approved

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Article 2 | FAKE | LOW COMPLEXITY | Link to the original article:
<https://www.frontnieuws.com/nasa-geeft-toe-dat-de-klimaatverandering-natuurlijk-is-en-veroorzaakt-wordt-door-de-zon/>



The screenshot shows the FrontNieuws website header with the logo and a navigation menu. The menu items include: 5G, BIDEN CLAN, BILL GATES, COVID-19 CARTOONS, COVID-19 VACCINE, PHOENIX CLASSICS, FRONT NEWS MOVIE SCOOP, GRAPHENE OXIDE, GREAT RESET, CLIMATE, UKRAINE CONFLICT, POPULATION, and CONTACT FN. Below the header is a large image of the Earth from space, showing the Americas and the Atlantic Ocean. Overlaid on the bottom left of the image is a white text box with the article title: "NASA admits that climate change is natural and caused by the sun". Below the title, it says "May 17, 2020" and "14497" views.

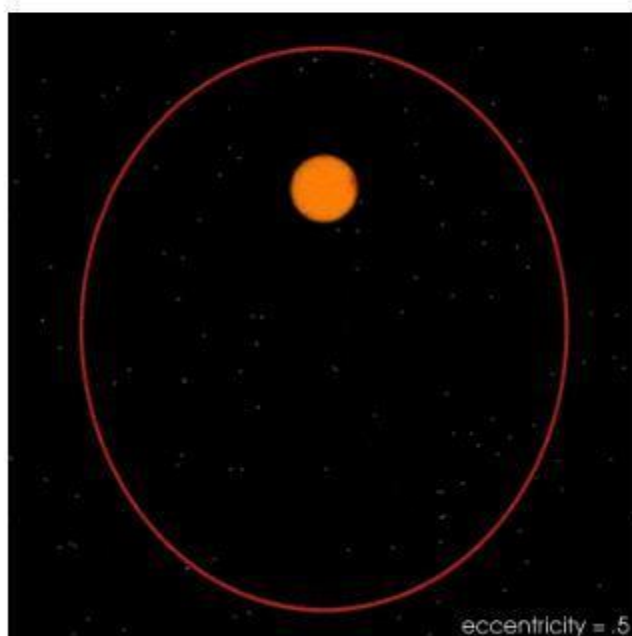
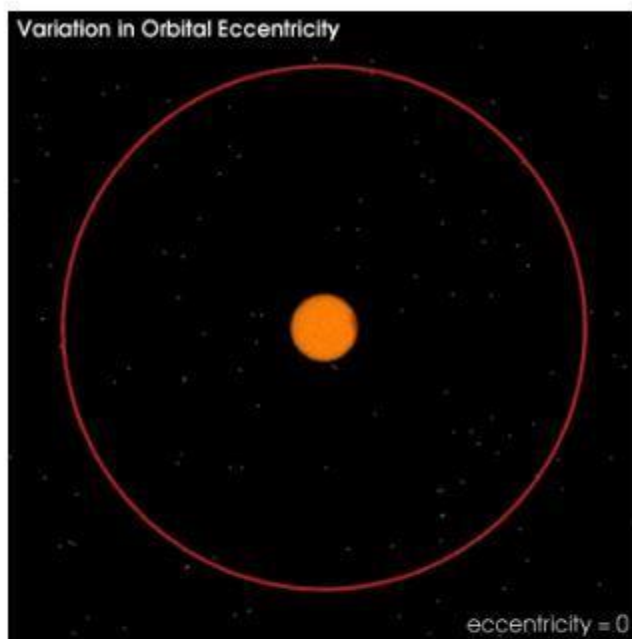
For more than 60 years, the National Aeronautics and Space Administration (NASA) has known that changes in the planet's weather conditions are perfectly natural and normal. But the space agency, for whatever reason, has decided to allow the so-called man-made warming scam to persist and spread, at the expense of human freedom.

It was in 1958, to be exact, when NASA first noticed that changes in the Earth's orbit around the sun and changes in the Earth's tilt were responsible for what climate scientists today call "warming" (or "cooling", depending of their agenda). In other words, in no way are humans warming or cooling the planet by driving fossile-fuel powered vehicles or eating beef. In 2000, NASA published on its Earth Observatory website information about Milankovich's climate theory, which shows that the planet is actually changing due to factors that have absolutely nothing to do with human activities. However, this information has still not made it into the mainstream media after 19 years, which is why "climate defenders" are now claiming that we actually have only 18 months or 12 years left before the planet dies from excess carbon dioxide (CO2).

But the truth is much more consistent with what Serbian astrophysicist Milutin Milankovitch, after whom Milankovitch's climate theory is named, has suggested. Namely, the differences in solar radiation, which hit the Earth in different ways and at different times, exert the greatest influence on the Earth's changing climate patterns.

The Earth's Orbit

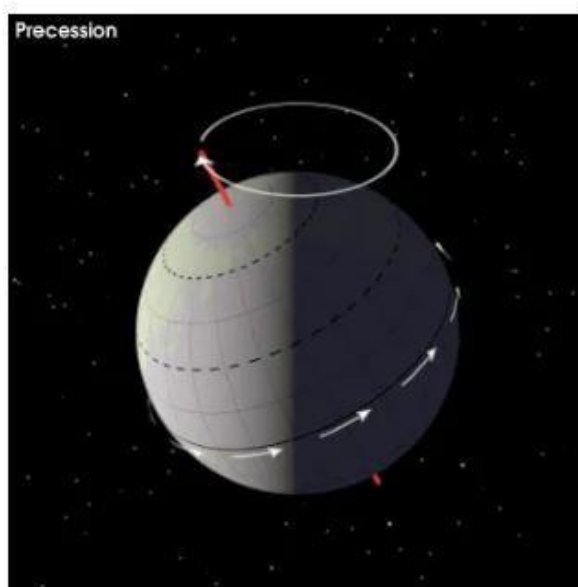
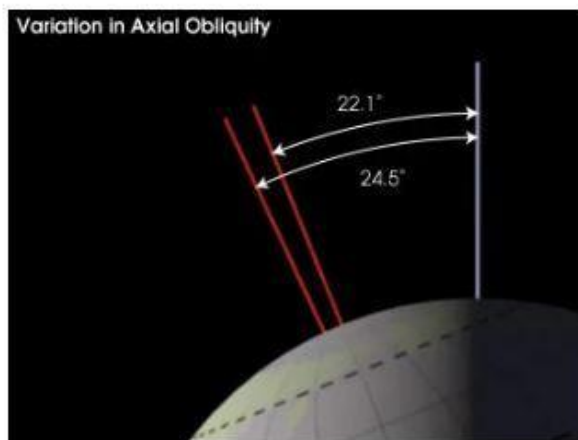
The following two images (by Robert Simmon, NASA GSFC) help illustrate this, the first shows the Earth orbiting around the sun with a value close to zero and the second shows the Earth orbiting around the sun with a value of 0,07. This change in value is represented by the oval shape in the second image, which has been deliberately exaggerated to show the massive change in the distance between the Earth and the Sun depending on whether the earth is closest to the sun or most distant from the sun.



The Earth's Tilt.

Regarding the tilt of the Earth, the two images below (Robert Simmon, NASA GSFC) show how much the tilt of the Earth can shift. At higher degrees of tilt, Earth's seasons become much more extreme, while at lower degree's of tilt they become much milder. Similarly, Earth's orbit around the

sun can strongly influence the seasonal extremes between the two hemispheres, depending on which hemisphere is closest to the sun.



It should be mentioned that “climate” means “condition” in Dutch. The word was chosen because the entire day side of the Earth is equally irradiated by the Sun, but the heating depends solely on the angle of the sunrays that hit the Earth's surface. At the warm equator, the angle is about 90°; at the cold poles it is much flatter.

Milankowitsch was able to develop a comprehensive mathematical model that can calculate the surface temperatures on the Earth far back in time, and the conclusion is simple: the Earth's climate has always been changing and is in a state of constant change, without our intervention as human beings.

When Milankovitch first presented his model, it was ignored for almost half a century. Then, in 1976, a study in the journal *Science* confirmed that Milankovich's theory was indeed correct and that it corresponded to different periods of climate change that have occurred throughout history.

In 1982, six years after the publication of this study, the National Research Council of the US National Academy of Sciences accepted Milankovich's theory as real and declared it true:

... orbital variations remain the most thoroughly studied mechanism of climate change on timescales of tens of thousands of years and are by far the clearest case of a direct effect of changing solar radiation on the Earth's lower atmosphere.

If we had to sum it all up in one simple sentence, it would be this: The biggest factor influencing the weather and climate pattern on Earth is the sun, or rather the period of the sun. Depending on the Earth's position relative to the sun at any given time, climate conditions will vary dramatically, even producing drastic deviations that challenge everything people thought they knew about how the Earth works.

But instead of accepting this fact, today's climate "scientists", along with the left-wing, and increasingly right-wing politicians, and of course the mass media, are urging that non-reusable supermarket shopping bags and non-electric vehicles will quickly destroy the planet, and that we absolutely must introduce a global climate tax as a solution.

The climate debate is not about science. It is an attempt to politically and economically control the population by the elite, writes a commentator on the [Hal Turner Radio Show](#).

And it is another way of dividing the population against itself, with some believing in man-made global warming and others not believing, i.e. divide and conquer.

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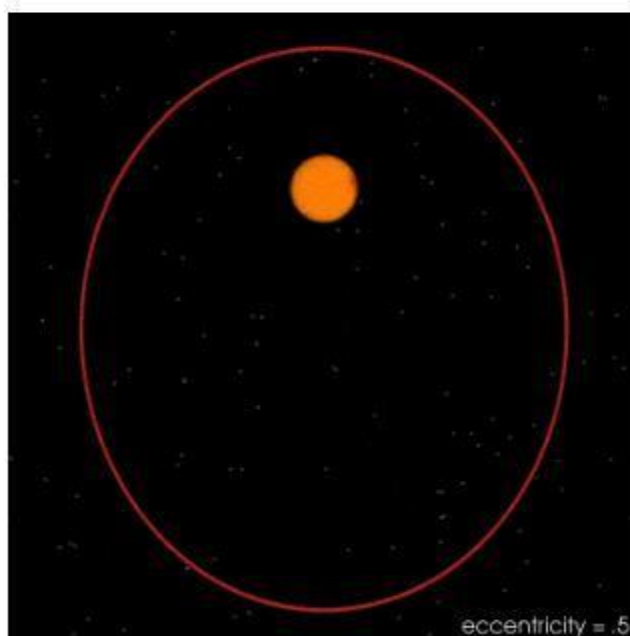
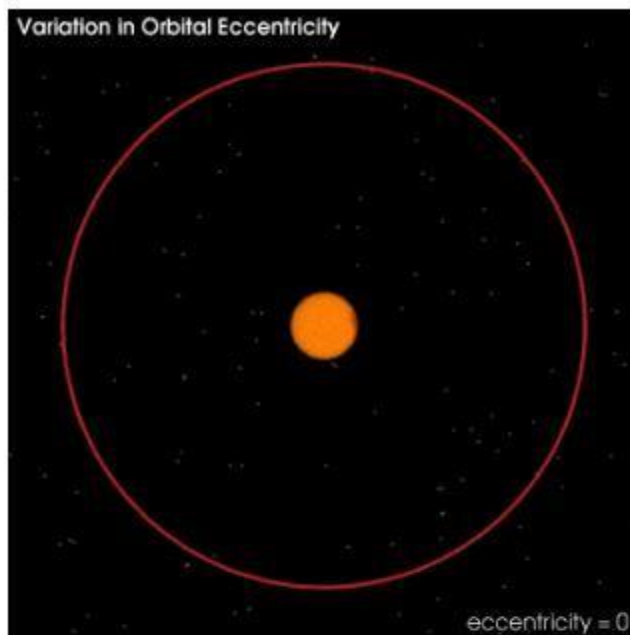


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The following two images (by Robert Simmon, NASA GSFC) help illustrate this, the first shows the Earth orbiting close to zero (Eccentricity: from eccentric, off center) and the second shows the Earth orbiting 0,07. This orbital change is represented by the eccentric, oval shape in the second image, which has been deliberately exaggerated to show the massive change in the distance between the Earth and the Sun depending on whether it is at perihelion or aphelion .

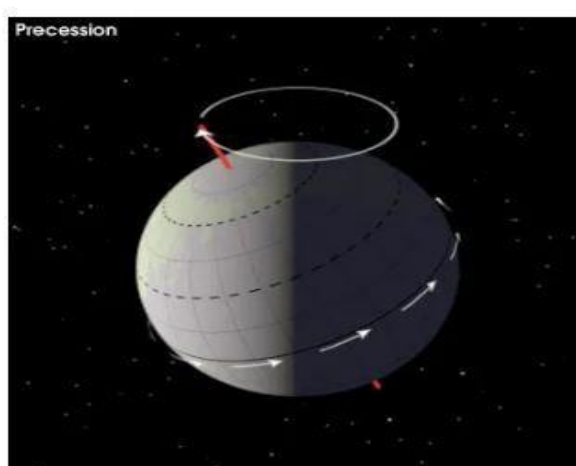
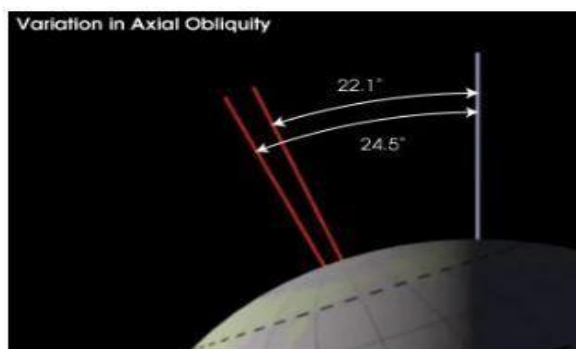


Even the maximum eccentricity of Earth's orbit – 0.07 – wouldn't be representative at a website's resolution , [notes the Hal Turner Radio Show](#) .

Nevertheless, at the current eccentricity of 0.017 at perihelion, the Earth is five million kilometers closer to the sun than at aphelion.

The biggest factor that influences the Earth's climate is the sun

Regarding the tilt of the Earth or the change in axial tilt, the two images below (Robert Simmon, NASA GSFC) show how much the Earth can shift, both on its axis and around its rotational orientation. At higher inclinations, Earth's seasons become much more extreme, while at lower inclinations they become much milder. Similarly, Earth's axis of rotation can strongly influence the seasonal extremes between the two hemispheres, depending on which hemisphere is aligned with the Sun at perihelion.



It should be mentioned that “climate” means “condition” in Dutch. The word was chosen because the entire day side of the Earth is equally irradiated by the Sun, but the heating depends solely on the angle of incidence, the inclination of the rays relative to the Earth's surface. At the warm equator, the angle is about 90°; at the cold poles it is much flatter.

Milankowitsch was able to develop from these different variables a comprehensive mathematical model that can calculate the surface temperatures on the Earth far back in time, and the conclusion is simple: the Earth's climate has always been changing and is in a state of constant change, without our intervention as human beings.

When Milankovitch first presented his model, it was ignored for almost half a century. Then, in 1976, a study in the journal Science confirmed that Milankovich's theory was indeed correct and that it corresponded to different periods of climate change that have occurred throughout history.

In 1982, six years after the publication of this study, the National Research Council of the US National Academy of Sciences accepted Milankovich's theory as real and declared it true:

... orbital variations remain the most thoroughly studied mechanism of climate change on timescales of tens of thousands of years and are by far the clearest case of a direct effect of changing solar radiation on the Earth's lower atmosphere.

If we had to sum it all up in one simple sentence, it would be this: The biggest factor influencing the weather and climate pattern on Earth is the sun, or rather the period of the sun. Depending on the Earth's position relative to the central star at any given time, climate conditions will vary dramatically, even producing drastic anomalies that challenge everything people thought they knew about how the Earth works.

But instead of accepting this fact, today's climate "scientists", along with the left-wing, and increasingly right-wing politicians, and of course the mass media, are urging that non-reusable supermarket shopping bags and non-electric vehicles will quickly destroy the planet, and that we absolutely must introduce a global climate tax as a solution.

The climate debate is not about science. It is an attempt to politically and economically control the population by the elite, writes a commentator on the Hal Turner Radio Show .

And it is another way of dividing the population against itself, with some believing in man-made global warming and others not believing, i.e. divide and conquer.

TAGS Europe Phoenix classics climate



Previous article

The Coronavirus is deadly to globalization

Next article

NASA hides page saying sun is primary climate driver, and clouds and particles are more important than greenhouse gases

APPENDIX B: Items used to measure *Perceived News Accuracy*

Item number	Question
1	On a scale of 1 to 5 and to the best of your knowledge, how accurate do you think this news article is?
2	On a scale of 1 to 5 and to the best of your knowledge, how trustworthy do you think this news article is?
3	On a scale of 1 to 5 and to the best of your knowledge, how manipulative do you find this news article to be?

APPENDIX C: Items used to measure *Involvement*

Item number	Question
1	On a scale of 1 to 5, how much did you thought it was important to be informed by this news article?
2	On a scale of 1 to 5, how much did you feel involved with the risks of climate change that were portrayed in this news article?
3	On a scale of 1 to 5, how much were you interested in the risks of climate change that were portrayed in this news article?
4	On a scale of 1 to 5, how much did you believe that the risks of climate change that were portrayed in this news article can affect you?

APPENDIX D: the 10 item CRT-V

Item number	CRT item
1	Mary's father has 5 daughters but no sons – Nana, Nene, Nini, Nono. What is the fifth daughter's name probably? <i>Correct answer: Mary, Intuitive answer: Nunu.</i>
2	If you were running a race, and you passed the person in 2 nd place, what place would you be in now? <i>Correct answer: 2nd, Intuitive answer, 1st</i>
3	Its a stormy night and a plane takes off from JFK airport in New York. The storm worsens, and the plane crashes-half lands in the United States, the other half lands in Canada. In which country do you bury the survivors. <i>Correct answer: you do not bury survivors, intuitive answer: USA.</i>
4	A monkey, a squirrel, and a bird are racing to the top of a coconut tree. Who will get the banana first, the monkey the squirrel or the bird? <i>Correct answer: There is no banana on a coconut tree, intuitive answer: the bird</i>
5	In a one-story pink house, there was a pink person, a pink cat, a pink fish, a pink computer, a pink chair, a pink table, a pink telephone, a pink shower – everything was pink! What color were the stairs probably? <i>Correct answer: There are no stairs in a one story house, intuitive answer: pink.</i>
6	How many of each animal did Moses put on the ark? <i>Correct answer: none, intuitive answer: two.</i>
7	The wind blows west, An electric train runs east. In which cardinal direction does the smoke from the locomotive blow? <i>Correct answer: an electric train does not produce smoke; intuitive answer: west.</i>
8	If you have only one match and you walk into a dark room where there is an oil lamp, a newspaper and wood- which thing would you light first? <i>Correct answer: The match, intuitive answer: the oil lamp.</i>
9	Would it be ethical for a man to marry the sister of his widow? <i>Correct answer: not possible, intuitive answer: No.</i>
10	Which sentence is correct: (a) 'the yolk of the egg are white or (b)'the yolk of the egg is white' <i>Correct answer: The yolk is yellow, Intuitive answer: b.</i>