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(Un-)scientifically Spun: Narratives, Belief Updating, and Pro-Environmental Behavior

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Abstract
In an experiment conducted with 2346 US residents, we examine the effect of content (positive/ negative/ inconclusive) and style (scientific/unscientific) of narratives about CO_2 emissions on belief updating and pro-environmental behavior. We use the Work for Environmental Protection Task (WEPT) by Lange and Dewitte (Behave Res Methods 54:133–145, 2022) as a proxy for pro-environmental behavior. Narratives are constructed using the natural language processing chatbot ChatGPT. We find that negative narratives significantly increase concern regarding CO_2 emissions, while positive narratives significantly decrease concern, with the latter effect being significantly larger in terms of absolute value. For inconclusive narratives, the effect on beliefs depends on prior beliefs: Subjects with low prior beliefs increase their concern, whereas subjects with high prior beliefs decrease their concern. Moreover, we find that the unscientific style has a stronger effect on belief updating than the scientific style. Neither content nor style affects pro-environmental behavior significantly.

Keywords Narratives · Belief updating · Pro-environmental behavior · Environmental attitude · Artificial intelligence

JEL Codes Q54 · D83 · D91

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1 Introduction

With growing evidence showing that facts alone are not enough to change people's minds (Larson and Broniatowski 2021)[1], persuasive scientific communication is vital to bridging the science-action gap in climate change efforts (Moser and Dilling 2011). While experts can access established guidelines for scientific communication (Bolsen and Shapiro 2018; Badullovich et al. 2020), there is scant research about what makes texts appear scientific to laypersons (Thomm and Bromme 2012) – and whether there are (economic) consequences to such perceptions. This is also a question of increasing relevance in a world where defining and identifying pseudoscience has proved to be a challenge (Zaboski and Therriault 2020), denial of scientific facts regarding climate change can create polarized beliefs (Drummond and Fischhoff 2017b), and there is increasing use of AI in popular climate communication (Vaghefi et al. 2023). Recently, attention has shifted towards storytelling, or to the narratives with which information is presented, in both conveying or combating scientific misinformation (Dahlstrom and Scheufele 2018). Our paper addresses this topic by asking the question: Can the content and style of a narrative influence beliefs and economic behavior?

To answer this question, we conduct an online experiment with 2346 US participants recruited using the survey platform Cint, and present subjects with different narratives on the subject of CO_2 emissions. Within this context, we study whether the content and style of a narrative – scientific or unscientific – affect subjects' belief updating and pro-environmental behavior, as measured by a proxy task. A narrative in our experiment is defined as a short body of text that ties together facts about CO_2 emissions into a cohesive story with a conclusion regarding the environmental impact of CO_2 emissions. In our experiment, we vary both the content (positive, negative, and inconclusive about the effect of CO_2 emissions on the planet) and the style (scientific and unscientific) across treatments. Scientific and unscientific styles are both constructed using the AI-driven natural language processing tool ChatGPT holding the content and length of narratives constant. We measure respondents' beliefs regarding the harmful effects of excessive CO_2 emissions on the environment on a scale of 1–100, and their pro-environmental behavior using the Work for Environmental Protection Task (WEPT) by Lange and Dewitte (2022) as a proxy for naturally occurring pro-environmental behavior.

We find that both content and style of a narrative impact belief updating. Negative narratives about the effects of CO_2 emissions on the planet significantly increase concern regarding the harmful effects of CO_2 emissions, and correspondingly, positive narratives significantly decrease concern regarding emissions. We find evidence of valence asymmetry – positive narratives decrease concern to a larger extent than negative narratives increase concern. Inconclusive narratives have no significant effect on belief updating when pooling over all initial beliefs. Secondly, the effect of narrative style depends on both the content of the narrative as well as the prior beliefs held by respondents. For those who were initially more concerned, the unscientific style of a negative narrative increases concern significantly more as compared to the scientific style. For those who were initially less concerned, the unscientific style of a positive narrative decreases concern significantly more as compared to the scientific style. Neither content nor style affect the pro-environmental effort exerted in

[1] Studies show that education, scientific literacy, and thinking styles can explain very little of the variance in skeptical attitudes toward controversial scientific topics (Hornsey et al. 2016, 2018). Moreover, people may hold incorrect beliefs about the effects of CO_2 emissions (Holmgren et al. 2019).

the WEPT. This may be due to that fact that initial beliefs still play a significant role in the decision to engage in the WEPT. While confrontation with narratives may induce decision-makers to update their beliefs, their previously held (long-term) beliefs still determine their behavior.

With the increasing dominance of AI-generated texts in both online and climate communication, our results hold implications for both policy makers and popular media alike. We show that the unscientific style of a narrative leads to more belief updating in the direction of prior beliefs, e.g. an initially concerned person becomes more concerned when confronted with a negative narrative written in an unscientific style than upon confrontation with a negative narrative written in a scientific style. This result provides evidence that media dialogues on climate change, as well as the presence of AI bots that rely on simplistic, exaggerated narratives, may contribute to the polarization of beliefs in society. Our results also imply that information presented in a scientific style may lead to smaller "drifts" in beliefs.

Secondly, our paper studies the economic consequences of laypersons' understanding of scientific communication. While public perception of science is a well-established field of study (Bauer 2009; Nisbet 2009), linguistic assumptions about science and what is understood as "scientific" by laypersons is a relatively under-researched topic with papers typically analyzing the lexical properties of scientific discourse present in popular media through qualitative studies (Dubovi and Tabak 2021; Grundmann and Scott 2014; Molek-Kozakowska 2017). Existing interdisciplinary papers on the consequences of style in scientific communication include Bromme et al. (2015), who consider the consequences of the use of citations and descriptions of research methods in defining scientific style as opposed to reporting just facts or "factual style" on participants' handling of conflicting science-based knowledge claims. Other papers investigating communication style have examined the effect of using an aggressive style such as personal attacks in communicating scientific issues (Chu et al. 2021; Yuan et al. 2019). To our knowledge, we are the first to use AI-generated formats to generate constructs of scientific and unscientific style.

Our paper connects to the literature on narratives in economics. Following the early discussions in Akerlof and Snower (2016) and Shiller (2017)[2], one branch of this literature focuses on how popular stories contribute to macroeconomic fluctuations: Flynn and Sastry (2024) define narratives as sets of prior beliefs about the economy held by agents that may generate persistent fluctuations in a business-cycle model. They use natural language processing to fit their model to identify narratives from US firms' report texts. Other recent papers on micro-founding narratives in macroeconomics also favor the approach of applying a rigorous theoretical definition of a narrative to extract narratives from text data including sources like open-ended surveys (Andre et al. 2023), Twitter data (Macaulay and Song 2022), and financial news media (Goetzmann et al. 2024).

A second vein of the narratives literature considers a broad number of applied-game theory settings that allow for agents to hold subjective models of their environment, including settings where decision-makers have imperfect information about the correlations between the economic variables relevant to them (Spiegler 2016). Eliaz and Spiegler (2020) and Eliaz et al. (2022) view political narratives as subjective causal structures that attribute economic outcomes such as GDP growth to factors such as government policies, while Schwartzstein and Sunderam (2021) use the definition of a narrative as a likelihood function that captures subjective models for interpreting historical data, used by an advisor to persuade a recipient.

[2] See, for instance, Sacco (2020) and Roos and Reccius (2024) for reviews of this literature.

In a different characterization, Bénabou et al. (2020) are concerned with the transmission and contagion of moral imperatives in shaping pro-social behavior and model narratives as signals that shift individuals' beliefs about the benefit from pro-social actions.

This largely theoretical literature is complemented by a small, but growing number of experimental papers speaking to how individuals choose, process, and retain information from narratives. Hillenbrand and Verrina (2022) follow Bénabou et al. (2020) in connecting narratives advocating (or advising against) pro-sociality to subjects' pro-social behavior. Barron and Fries (2023) adopt Schwartzstein and Sunderam's definition in an experiment where financial advisors choose interpretations (models) of financial data to guide investment decisions made by recipient investors. Other papers discuss the broader questions of how individuals choose between conflicting causal interpretations of variables and data (Kendall and Charles 2022; Ambuehl and Thysen 2024), or, more generally, how people form predictive models from data (Kendall and Oprea 2024) and recall information (Graeber et al. 2024). Experimental papers that use more general definitions of narratives as stories include Harrs et al. (2021) who show that exposure to news articles that convey pessimistic or optimistic narratives about the COVID pandemic alter participants' risk-taking behavior in incentivized economic games. Morag and Loewenstein (2023) find that participants who were asked to tell a story of an item they owned before they sold it had significantly higher valuations for the item. However, so far this literature does not address the connections between narratives and pro-environmental behavior.

Our paper is also adjacent to the recent literature on individual biases in belief-updating (Grether 1980; Benjamin 2019; Erkal et al. 2022), especially on the strand investigating how individuals respond to good and bad news (see, for example, Eil and Rao 2011; Coutts 2019; Barron 2021; Möbius et al. 2022). This strand of literature is rather distinct from our study since these papers are largely concerned with understanding deviations in belief-updating from a (typically) Bayesian benchmark in response to new information. While subjective beliefs about climate change may also be considered within this framework, it may involve additional assumptions regarding the distribution of priors (Cameron 2005). Moreover, in our context, treating the information from narratives as finite-dimensional signals would also involve making normative assumptions about the nature of the signal that the style of the narrative can provide, in order to have benchmarks for belief-updating. The paper therefore diverges from the economics on biases in belief-updating in these two aspects as we do not make prior assumptions about either the signal that the style of a narrative provides or the distribution of beliefs of subjects.

In this regard, our paper connects more closely to the body of inter-disciplinary literature on the determinants of beliefs regarding climate change (Hornsey et al. 2016) and climate skepticism (Hornsey et al. 2018); in parallel, we also add to the literature on the role played by narratives and framing in scientific communication as a channel of influence (Yang and Hobbs 2020). Beliefs regarding climate change are subject to cognitive biases (Zaval and Cornwell 2016; Holmgren et al. 2019), can be influenced by emotions (Nabi et al. 2018) and positive or negative framing (Dickinson et al. 2013), and are not necessarily created by a deficit in comprehension (Kahan et al. 2012). Research on the role played by narratives to influence environmental beliefs is relatively scant especially within the field of economics[3].

[3] Even in the broader literature, Moyer-Gusé et al. (2019) point out that while it is well-known that narratives can influence knowledge, attitudes, and behaviors across a variety of topics, within the body of research on environmental/science communication, relatively little has been done through the lens of narra-

Morris et al. (2019) distinguish between a factual account of information related to climate change on one hand, and on the other, an emotion-provoking, character-based detailed narration of the character's struggles to overcome obstacles caused by climate change. They find that narratives based on characters elicit a higher emotional response from respondents and promote pro-environmental behavior. Yet, their paper does not consider the role of scientific communication or style in this regard. A homologous line of research highlights the importance of storytelling in scientific communication of climate change (Dahlstrom 2014; Martinez-Conde and Macknik 2017; Dahlstrom and Scheufele 2018). However, so far there are no studies in this field focusing on the impact of scientific style on environmental beliefs and behavior, despite existing research showing both that the use of scientific jargon plays a role in science communication (Bullock et al. 2019), and the co-existence of scientific news and conspiracy theories create polarization within online communities (Bessi et al. 2015).

The rest of the paper is organized as follows: Sect. 2 explains the experimental setup and procedures, Sect. 3 presents and discusses the results, and Sect. 4 concludes.

2 Experimental Design

In the experiment, we study how the content and style of narratives affect beliefs and behavior. We implement six treatments in a between-subjects design. We vary the content of the narratives (stressing negative aspects of CO_2, stressing positive aspects of CO_2, or remaining inconclusive) and the writing style (scientific or unscientific). The experiment followed the steps as detailed below.

Prior belief elicitation. At the beginning of the experiment, we elicit our participants' beliefs about the effects of CO_2 in the environment.[4] More precisely, we ask "How harmful do you think current levels of CO_2 are for the environment, on a scale of 0–100?" where 0 means not harmful at all and 100 represents very harmful.

Treatment variation: Narratives. In the next step, subjects are confronted with narratives which vary in their writing style and in their content, but are comparable in terms of their length. Subjects did not receive any information on the source of the narratives. Each narrative elaborates either on a positive aspect of CO_2 for the environment, on a negative aspect, or remains inconclusive. Which narrative a subject is confronted with is determined randomly. Each subject sees only one narrative. Details on narratives are provided in Sect. 2.1.

Posterior belief elicitation. After subjects have read the narratives, we elicit their beliefs about the harmfulness of CO_2 again, using the same question and the same scale. Note that we do not remind subjects of their previously stated beliefs. In fact, the elicitation of their posterior beliefs is analogue to the elicitation of their prior beliefs (see Fig. A2). Neither the elicitation of their prior nor of their posterior beliefs is incentivized.

Real effort task. After the elicitation of their posterior beliefs, subjects can choose to work on a real effort task – the Work for Environmental Protection Task (WEPT) (Lange

tive persuasion. Existing papers may focus more on the utility of narratives, such as those in film and media (McCormack et al. 2021), on the effect of narratives on intentions of engage in pro-environmental behaviors (Moyer-Gusé et al. 2019) or risk perceptions and preferences for the regulation of environmental hazards (Cooper and Nisbet 2016).

[4] Screenshots of the experimental decision screens can be found in Sect. A of the Appendix.

and Dewitte 2022).[5] When stating their beliefs, subjects do not know that they will be confronted with the WEPT nor that they will work on any task that may be of environmental relevance. Hence, it is unlikely that they misstate their beliefs as an excuse to exert less effort in the WEPT.

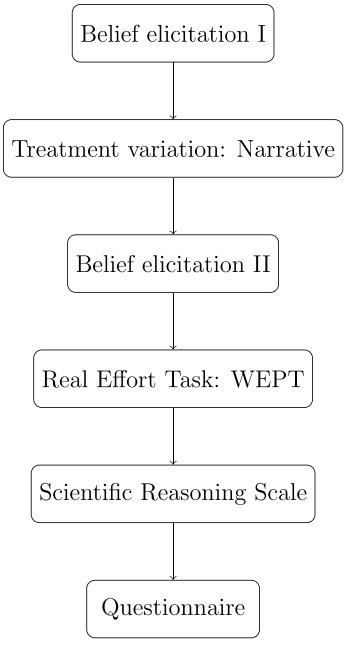
Scientific reasoning and demographics. Before concluding the experiment with a questionnaire on demographics, political views, and environmental concerns, we elicit the subjects' ability for scientific thinking using the Scientific Reasoning Scale (Drummond and Fischhoff 2017a). See Fig. 1 for an overview of the timeline of the experiment.

2.1 Narrative Generation

We use ChatGPT to create the narratives. Using AI to generate the narratives serves two further purposes, the first being that it allows us to closely match the content and the length of each narrative type (negative, positive, inconclusive) while manipulating the writing style in a way that is consistent across all the narratives. Second, it allows us to hold the source of the narratives as constant, controlling for variance in potential biases about narratives from different sources. Subjects do not receive any information on the source of the narratives, controlling for any reputational concerns that may affect our results across the treatments.

We construct the narratives using ChatGPT-3 by first using simple prompts to describe popular beliefs regarding climate change (for instance, the prompt used was: "Explain the belief that the sun causes climate change") and then using a second prompt to create the scientific and unscientific narratives: ("repeat the contents in a scientific style" or "repeat the contents in an unscientific style"). The resulting passages were then checked manually to ensure that the scientific and unscientific paragraphs for each narrative were approximately

Fig. 1 Structure of the experiment



[5] See Figs. A4–A7 in the Appendix.

the same length, and contained the same number of facts presented in the same order. We did not correct or edit the narratives generated in any other way, relying entirely on artificial intelligence to both create the narrative based on the topic, as well as determine the discourse style that it considers as scientific or unscientific. This is important for several distinct reasons. First, existing studies can vary in the rigorous definition of scientific style versus unscientific style and a unanimous global definition is unclear[6]. Second, studies also find that perceived 'scientific-ness' may be confounded by other variables, such as ease of understanding (Stricker et al. 2020). Recognizing this, the literature on laypersons' understanding of scientific texts has extensively researched whether it is scientific arguments, or rather 'peripheral criteria' such as the use of references, statistics, or the fame of authors that influence the extent to which science communication is deemed trustworthy (Jonas et al. 2024). These peripheral criteria being tested may determine what is defined as scientific in these studies. Selecting precisely determined criteria for characterizing scientific studies therefore has the advantage of pinpointing the elements of scientific research that can be used to influence public communication of science. Since the focus of our research is on the impact on environmental beliefs and behavior, we rely entirely on AI generated content as well as constructs of scientific and unscientific styles, and use a pre-study that explicitly tests for subjects' perceptions of scientific writing style for the selection of the final narratives. We also explicitly test for subjects' comprehension of the narratives, as well as their credibility and consistency with prior knowledge.

In order to select the narratives for the main experiment, we ran an extensive pre-study. In the pre-study, we elicited subjects' comprehension of the narratives, their perceived credibility, their consistency with prior knowledge, as well as their perception of the writing style as scientific or as unscientific.[7] More precisely, we tested pairs of narratives with the same content, but different writing styles. We did not observe significant differences in terms of comprehension of the tested narratives. However, the difference in perceived writing styles varied across narrative pairs. For the main experiment, we chose the narratives with the largest gap in perceived writing style between the scientific and the unscientific narrative. For the narratives we used in the experiment, see Sect. C.1 in the Appendix.

2.2 Real Effort Task

We use the Work for Environmental Protection Task (WEPT) (Lange and Dewitte 2022) to elicit whether changes in beliefs manifest in changes in behavior. The WEPT is a number identification task. In the task, subjects are confronted with up to ten pages with each page containing 40 two-digit numbers. Subjects had to identify the numbers with an even first digit and an odd second digit. For each correctly solved page, € 3 were donated to Atmosfair, a non-profit organization which offers carbon offsets. Note that these donations are only

[6] Thomm and Bromme (2012), for instance, define a scientific text as one that has citations, descriptions of methodology, and use a passive voice. They distinguish these from texts written in factual style: that is, no citations or methodology mentioned, and that use an active voice. More recently, Jonas et al. (2024) define 'low' scientific texts as those that have evaluative language (e.g. "This impressive study"), omitted references and research method descriptions, presented results descriptively, and used exclamations (e.g. "Don't you think?!") and 'high' scientific studies as those that use neutral language, references to other journal articles, more precise method descriptions, and present results as supported by statistics.

[7] All narratives used in the experiment are received credibility rating of above 50 on a scale from 0 to 100 in the pre-study. Hence, they are considered – on average – as credible.

Table 1 Numbers of participants

		Style	
		Scientific	Unscientific
Content	Negative	390	392
	Inconclusive	400	388
	Positive	388	388

carried out with a probability of 1%. Subjects could opt out at any time during the real effort task or decide to solve all ten pages.

2.3 Experimental Procedures

The experiment was programmed using Qualtrics and participants were recruited from the United States through Cint in fall 2023, earning on average € 2.80 each. We aimed to recruit 400 participants per treatment for the main experiment. The actual numbers are slightly smaller as some subjects did not complete the study (see Table 1). The median time spent working on the experiment was 19 minutes, with an average duration of 21 minutes. In total, € 204 were donated to Atmosfair. The experimental design, the pre-study, and the main analyses were preregistered on the online repository OSF.[8]

3 Results

Our sample consisted of 2346 adults (41% male) between the ages of 18 and 84 years, with the panel almost evenly split between those with at least an undergraduate degree (50.3%) and those without college education, and across the US political spectrum (48% Democrats) .[9] Table 2 presents summary statistics for the averages of our main variables of interest: the initial and final beliefs, as well as the number of pages attempted, the number of pages solved, and the scores on the SRS scale, for each treatment of the study (**Neg**ative **Sc**ientific, **Neg**ative **Unsc**ientific, **Pos**itive **Sc**ientific, **Pos**itive **Unsc**ientific, **Incon**clusive **Sc**ientific and **Incon**clusive **Unsc**ientific).

3.1 Belief Updating

Figure 2 reports the average levels of reported initial and final beliefs of respondents on a scale of 0–100 for each treatment, categorized by the content of the narrative (negative, positive, and inconclusive) and style (scientific and unscientific). As can be seen from the table, the initial beliefs do not seem to vary between treatments. Hence, we may conclude that our treatment variation succeeded. The final beliefs, however, vary depending upon the narratives participants were confronted with suggesting non-negligible treatment effects. We present details of the effect of narrative content and style on belief updating below.

[8] See https://osf.io/bnkzm/?view_only=92a244e899a34333a923d51790db22e2.

[9] See Table B.1 in the Appendix for a full panel of the demographics.

Table 2 Averages of outcome variables by treatments

	Neg Sc	Neg UnSc	Pos Sc	Pos UnSc	InCon Sc	InCon UnSc
Initial Beliefs	63.35	63.94	64.74	64.60	63.99	63.32
	(26.66)	(27.49)	(28.94)	(27.71)	(27.23)	(27.37)
Final Beliefs	68.64	70.54	48.21	44.07	64.89	63.52
	(26.96)	(27.28)	(35.02)	(34.68)	(27.13)	(27.95)
Update	5.29	6.59	−16.53	−20.52	0.90	0.20
	(16.55)	(16.57)	(30.13)	(29.93)	(12.08)	(12.72)
Agreed to participate in WEPT	0.81	0.82	0.80	0.84	0.82	0.82
	(0.39)	(0.39)	(0.40)	(0.37)	(0.39)	(0.39)
Pages attempted of the WEPT	6.04	6.25	6.04	6.25	5.96	6.22
	(3.85)	(3.80)	(3.90)	(3.75)	(3.87)	(3.78)
Pages solved of the WEPT	3.69	4.17	3.72	3.85	3.85	3.89
	(3.92)	(4.04)	(3.96)	(3.99)	(3.97)	(3.99)
SRS score	5.47	5.42	5.68	5.37	5.71	5.74
	(2.22)	(2.19)	(2.30)	(2.32)	(2.25)	(2.31)

Notes: Update = Initial Beliefs - Final Beliefs

Initial and Final Beliefs were scored on a scale 0–100

Agree to participate: binary, 0 or 1

Pages attempted, solved: between 0 and 10. SRS score: Scientfic Reasoning Scale score, between 0 and 11

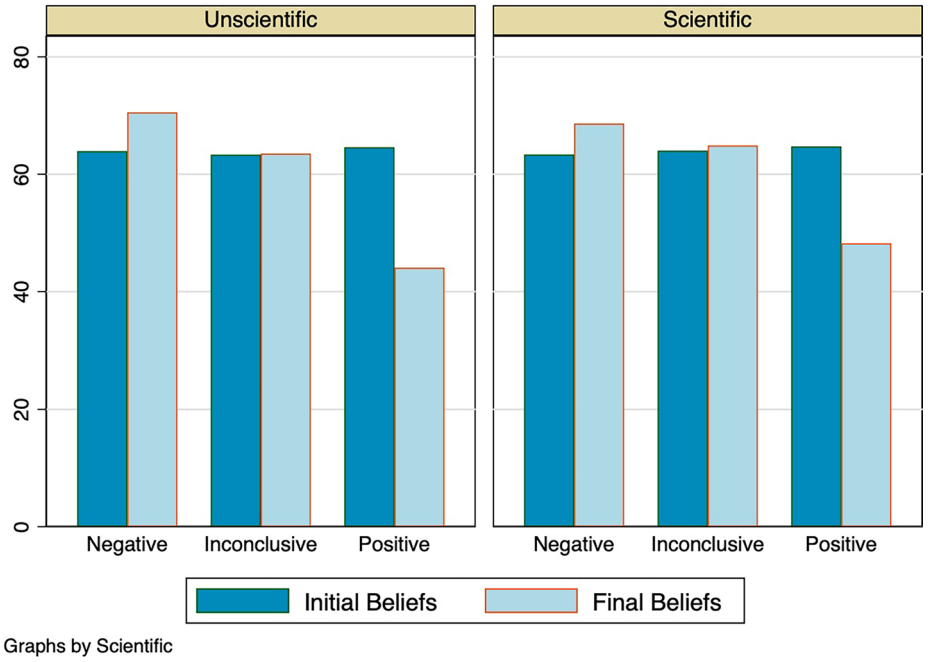


Fig. 2 Average beliefs across treatments

3.1.1 The Effect of the Content

We take a closer look at negative narratives first. For this part of the analysis, we pool over both styles (scientific and unscientific) and consider only the impact of the content of the narrative. After seeing a negative narrative, participants become significantly more concerned about the harmfulness of CO_2 and update their beliefs upwards (2-sided t-test Initial vs. Final Beliefs: 63.646 vs. 69.590, $p < 0.001$). This increase in concern is mainly driven by those who are initially less concerned, i.e. those participants whose initial beliefs lie below or at the median belief of 70 (two-sided t-test Initial vs. Final Beliefs: 42.231 vs. 53.432, $p < 0.001$). Those who were initially more concerned (Initial Beliefs > 70), do not engage in significant belief updating (2-sided t-test Initial vs. Final Beliefs: 85.841 vs. 86.335, $p = 0.353$). Focusing on the average effect of exposure to the negative narrative, we may formulate our first result:

Result 1 *Exposure to a negative narrative increases the concern towards*CO_2*emissions significantly.*

The effect of exposure to a positive narrative mirrors the effect of exposure to a negative narrative, i.e. participants exhibit lower concern for CO_2 emissions (2-sided t-test Initial vs. Final Beliefs: 64.669 vs. 46.144, $p < 0.001$). As can be seen from Fig. 2, the magnitude of this effect in terms of absolute value is significantly larger for positive than for negative narratives (2-sided t-test updating with positive narrative vs. updating with negative narrative: 19% points vs. 6% points, $p < 0.001$).

While for negative narratives, belief updating was mostly driven by those with below-median beliefs, this is not the case for positive narratives: Both subjects with below-median initial beliefs[10] and those who initially showed higher concern for the harmfulness of CO_2 emissions[11] significantly lower their beliefs on the harmfulness of CO_2.

Result 2. *Exposure to a positive narrative decreases the concern towards*CO_2*emissions significantly. Moreover, the decrease in concern is larger than the increase in concern when confronted with a negative narrative.*

Finally, we consider the inconclusive narratives: Pooling over all levels of concern, we find that exposure to inconclusive narratives does not have a significant effect on the participants' beliefs (2-sided t-test Initial vs. Final Beliefs: 63.662 vs. 64.216, $p = 0.211$). Splitting the sample into those with below-median and those with above-median initial beliefs, we observe that participants with initially lower beliefs (≤ 70) slightly increase their concern (2-sided t-test Initial vs. Final Beliefs: 42.085 vs. 44.803, $p = 0.0001$) and participants with initially higher beliefs (> 70) slightly reduce their concern (2-sided t-test Initial vs. Final Beliefs: 85.907 vs. 84.229 , $p = 0.0015$), such that overall the effects cancel out.

Note that, while both effects are significant, the size of the effects is rather negligible. Moreover, both effects point towards the median, i.e. those with higher concern decrease their concern and those with lower concern increase their concern. Hence, exposure to

[10] Two-sided t-test Initial vs. Final Beliefs for initial beliefs below and equal to 70: 40.561 vs. 28.216, $p < 0.001$

[11] Two-sided t-test Initial vs. Final Beliefs for initial beliefs above 70: 86.753 vs. 62.567, $p < 0.001$

an inconclusive narrative seems to somewhat decrease differences in the level of concern between those with initially higher and those with initially lower beliefs. Interestingly, this finding suggests that participants do not focus on those aspects of the inconclusive narrative that support their initial views and neglect those that contradict their initial views. Instead, they appear to focus on those pieces of information that contradict their initial views, such that overall, beliefs become slightly more similar.

Result 3 *Inconclusive narratives do not have a significant effect on changing the beliefs.*

As expected, the effects of positive and negative content point into opposite directions as summarized in Results 1 and 2. More interestingly however, our paper finds that in absolute value positive narratives have a larger effect on beliefs than negative narratives which is especially surprising since both types of narratives reach similar scores for their perceived credibility in the pre-study.[12] This finding is important in highlighting the need for a more nuanced understanding of the determinants of valence asymmetry in response to climate change communication.

3.1.1.1 Discussion Valence asymmetry, or differential processing of positive and negative content, is a well-recognized phenomenon in psychology (Fazio et al. 2015; Unkelbach et al. 2020). It remains, however, a relatively under-studied topic in economics, with papers finding evidence of biases towards positive news, negative news, as well as no biases, depending upon contextual features involved in the experimental setting (Barron 2021). This literature offers three main channels as explanations for why biases in belief updating may exist: *motivated reasoning*, that individuals get utility from confirming their priors (Eil and Rao 2011); *reputational concerns*, that individuals trust the source that aligns with their priors (Charness et al. 2021); and finally, the hypothesis that belief-updating is not related to preferences, but rather, purely *cognitive biases* which result in deviations from a bayesian benchmark (Tversky and Kahneman 1983; Erkal et al. 2022).

The relevance of valence asymmetry in climate change communication has also been researched only to a limited extent. Some papers report evidence for differences in responses to negative and positive messaging (Hornsey and Fielding 2016; Diamond and Urbanski 2022), while others find no effect (Chiancone et al. 2024). In contrast to the belief-updating literature, papers in this field consider the effect of narrative framing on emotions to identify potential channels for shifting beliefs.[13]Hornsey and Fielding (2016) investigate the impact of optimistic and pessimistic messages about the extent to which mankind has succeeded in slowing down carbon emissions. They find that optimistic messages are correlated with higher feelings of hope, and are less effective in increasing self-reported desires to take action to mitigate climate change than pessimistic messages. Diamond and Urbanski (2022) find that reading negative news media articles leads to increases in the level of concern

[12] For a thorough analysis of the narratives in the pre-study, see Sect. C.2 in the Appendix.

[13] Hornsey and Fielding (2016) for instance, discuss two different models by which a message may have an effect on emotions. The complacency model suggests that positive messages regarding climate change are associated with a decreased perception of risk, and hence the decreased worry and concern is reflected in changes in beliefs. The motivational model suggests that positive messages trigger hope and increase motivation, triggering changes in beliefs.

for climate change[14] that persist over a period of 8 weeks, as compared to positive articles where concern increases but does not persist over time. However, the difference in levels of concern for the two groups is rather small compared to the very large differences observed in our results. Moreover, we note that the literature on climate change communication does not entirely rule out the role of reputational concerns[15], cognitive biases (Holmgren et al. 2019), or motivated reasoning (Hart and Nisbet 2012) as potential drivers for environment-related beliefs.

Finally, scholars in behavioral and cognitive psychology have long recognized that *affect*, or initial judgmental responses to information, are frequently used by individuals to make effective decisions (Cooper and Nisbet 2016)[16]. While measuring affect may include the study of judgmental heuristics in the form of cognitive biases (Tversky and Kahneman 1983), other definitions of affect include an understanding that it is an element of information processing that is distinct from both emotion and purely cognitive bias.,[17] Emotions typically refer to intense, short-lived feelings that have a known cause and a cognitive component (e.g., happiness, fear) (Cooper and Nisbet 2016).).[18] Affect has been commonly associated with information-processing based on narratives (Slovic 2004). Narrative engagement has been also previously been noted to interact with positive and negative affect from respondents differently based on content (Cooper and Nisbet 2016; Moyer-Gusé et al. 2019).

With several factors at play, the answer to the question of whether one of the above mentioned channels is more likely to influence our results on valence asymmetry than another, is likely complex. Since our subjects do not have any information about the source of the narratives, reputational concerns may be an unlikely channel for the observed asymmetry in belief-updating in our case. Given that the setting of the narrative is not entirely analytical information, it is similarly unlikely that our results are fully explained in terms of a purely cognitive bias. It is however unclear whether our results on asymmetric updating are driven by motivated reasoning, emotional responses, or narrative affect.

Our contribution to the literature on valence asymmetry and belief-updating is therefore two-fold. First, we add to the findings from recent literature in economic decision-making cautioning against interpreting asymmetric updating as purely motivated by psychological biases (Coutts 2019). Secondly, recent research suggests that the evidence for motivated reasoning as the sole explanation for shifts in climate change beliefs is mixed (Druckman and McGrath 2019; Bayes and Druckman 2021). In noting this issue, we echo calls for future research that distinguishes channels for motivated reasoning from affective decision-

[14] Measured on a 7 point likert scale.

[15] Bolsen et al. (2019) find, for instance, that information about the source of a message affects individuals' beliefs about climate change.

[16] *Affect* plays a central role in dual-process theories of thinking (Slovic 2004) that are foundational to the extensive literature on cognitive biases in economic decision-making. While some economists have argued that these biases may not relevant for real world settings where incentives for rational decision-making are higher, Enke et al. (2023) report that even providing very high-incentives are not enough to de-bias participants.

[17] Slovic (2004), for instance, defines "affect" as the specific quality of "goodness" or "badness" experienced as a state of feeling, with or without consciousness, that clearly demarcates a positive or negative quality of a stimulus.

[18] Affect can be also distinguishable from mood, which usually refers to a low-intensity, potentially long-term feeling that does not have a definite cause or cognitive component (Finucane et al. 2003).

making in shaping environmental beliefs and behavior (Cooper and Nisbet 2016), a topic that is beyond the scope of the current research.

3.1.2 The Effect of Style

We next turn to the effect of the style of a narrative on belief updating. Pooling over all initial beliefs, we find that for negative narratives, the effect on belief updating does not differ across writing styles (2-sided t-test Updating Neg. Unscientific vs. Neg. Scientific: 6.594 vs. 5.289, $p = 0.2709$). Considering only those with initial beliefs below or at the median of 70 yields the same finding (2-sided t-test Updating Neg. Unscientific vs. Neg. Scientific: 11.677 vs. 10.730, $p = 0.6278$). Focusing on those with higher initial beliefs, however, we observe that they update significantly more when confronted with a negative narrative written in the unscientific style (two-sided t-test Updating Neg. Unscientific vs Neg. Scientific: 1.407 vs. −0.437, $p = 0.0832$).

For positive narratives, the style has a significant effect on the updating of beliefs: In absolute value and on average, subjects update more when confronted with a narrative written in the unscientific style (two-sided t-test Updating Pos. Unscientific vs. Pos. Scientific: −20.523 vs. −16.526, $p = 0.0641$). This finding is driven by those with below or at the median initial beliefs (2-sided t-test Updating Pos. Unscientific vs. Pos. Scientific: −15 vs. −9.647, $p = 0.0341$). For those with initially higher levels of concern, the updating is not affected by the style of the narrative (two-sided t-test Updating Pos. Unscientific vs. Pos. Scientific: −25.6617 vs. −22.730, $p = 0.3798$).

For the inconclusive narrative the style does not impact updating behavior (two-sided t-test Updating Incon. Unscientific vs. Incon. Scientific: 0.198 vs. 0.898, $p = 0.4290$). This holds both for the initially less concerned (two-sided t-test Updating Incon. Unscientific vs. Incon. Scientific: 1.852 vs. 3.549, $p = 0.2179$) and for the initially more concerned (two-sided t-test Updating Incon. Unscientific vs. Incon. Scientific: −1.489 vs. −1.862, $p = 0.7238$).

Result 4 *The impact of the style of a narrative depends on its content and its audience:*

1. *For inconclusive narratives, the style does not significantly affect belief updating.*
2. *For positive narratives, the unscientific style decreases the concern about the harm caused by* CO_2 *emissions significantly more than the scientific style among those who are initially less concerned.*
3. *For negative narratives, the unscientific style increases the concern for the harm caused by* CO_2 *emissions significantly more than the scientific style among those who are initially more concerned.*

Result 4 is a new finding, and shows that style does not affect belief updating of subjects with a low concern for CO_2 emissions who are confronted with a negative narrative, nor does it affect the updating behavior of those with a high concern for emissions who are confronted with a positive narrative. Put differently, Result 4 indicates that the style of a narrative does not have a significant effect on belief updating when prior beliefs are not "aligned" with the content of the narrative. When prior beliefs are "aligned" with the content of the narrative, the scientific style induces less belief updating than the unscientific style.

More importantly, Result 4 shows that depending upon prior beliefs and type of content, the effect of the unscientific style of a narrative skews beliefs more strongly in favor of pre-existing beliefs as compared to the scientific style. Viewed alternatively, the result implies that the scientific style of narratives leads to more conservativeness in belief updating in the direction of prior beliefs. Since the effect of style appears to interact with prior beliefs, Result 4 is adjacent to recent literature on how to overcome biases of motivated reasoning in climate change communication that so far has rather emphasized factors such as increasing numeracy (Hutmacher et al. 2024), and the role played by information on scientific consensus (van der Linden et al. 2015). However, in view of the previous discussion on asymmetric updating in the paper, the roles of emotion and asymmetric narrative affect on our results cannot be ruled out, and deserve further research.

3.1.3 The Effect of Demographics and Attitudes

To investigate if the scientific reasoning abilities (SRSscore), self-reported trust in science (ScienceTrust), age (older than 46 vs. younger), the subject's gender (male = 1 if the subject identifies as male and 0 otherwise) education, and political preferences influence belief updating, we complement our above-reported t-tests with OLS regressions (see Table 3). In the regressions, the outcome variable is the difference between the final and the initial belief. The dummy variable 'Scientific' captures if the narrative is written in the scientific style. We observe that the style of the narrative only has a significant impact on updating for positive narratives.[19] Here, the coefficient is positive and significant. Note that this complements our previous results: Updating for positive narratives is (normally) in the negative domain. Hence, a positive coefficient means that – in absolute value – there is less updating. Less updating for scientific narratives directly corresponds to more updating for unscientific narratives.

We find that older participants (aged 45+[20]) update more, i.e. they become more concerned than younger participants when confronted with negative narratives and more relaxed when confronted with positive narratives. Moreover, older participants (defined as above the median age) hold a lower level of initial beliefs across all three content types as compared to younger participants (in the cohort of 18–45 years). The effect on updating is strongest for positive narratives, where older respondents significantly update their beliefs by 22% points, as compared to younger participants who update by only 12% points (t-test (young) Initial vs. Final Beliefs: 71.49 vs. 59.25 ($p < 0.0001$), t-test (old) Initial vs. Final Beliefs: 61.09 vs. 39.27 ($p < 0.0001$)). The effect on belief updating is weaker for negative narratives: 4% points for younger participants, vs. 7% points for older participants but still significant for both age groups (t-test (young) Initial vs. Final Beliefs: (t-test (young) Initial vs. Final Beliefs: 70.38 vs. 74.49 ($p = 0.0001$), t-test (old) Initial vs. Final Beliefs: 59.31 vs. 66.43 ($p < 0.0001$)). Hence, we find that beliefs of older people are easier to manipulate in the context of climate change: Their *increase* in concern is larger when confronted with negative narratives and their *decrease* in concern is larger when confronted with positive

[19] This is in line with our t-tests reported above where (marginally) significant results for negative narratives were only found for subjects with above-median prior beliefs.

[20] Information on age was collected on 7 age groups (18–24)...(75–84), and the age group 45–54 was closest to the median.

Table 3 OLS on belief updating with VCE robust estimators

	(1)	(2)	(3)	(4)	(5)	(6)
	Negative	Negative	Positive	Positive	Inconcl.	Inconcl.
Scientific	−1.305	−0.671	3.997*	3.796*	0.699	0.820
	(−1.10)	(−0.57)	(1.85)	(1.83)	(0.79)	(0.91)
Age > 45		2.804**		−11.27***		−1.787*
		(2.16)		(−4.73)		(−1.71)
Male		−3.217***		2.589		0.0197
		(−2.63)		(1.18)		(0.02)
College		−1.296		−6.090*		−1.601
		(−0.66)		(−1.81)		(−1.00)
Bachelor		−5.385***		4.881		−0.602
		(−2.87)		(1.49)		(−0.39)
Master		−5.959***		−3.591		−1.043
		(−2.67)		(−0.92)		(−0.63)
ScienceTrust		0.0123		0.00308		−0.0285
		(0.30)		(0.05)		(−0.87)
Republican		3.423**		4.226*		−0.0661
		(2.28)		(1.72)		(−0.06)
Independent		5.243***		0.353		−0.549
		(2.65)		(0.11)		(−0.38)
OpClimCh		0.549***		−0.928***		0.122
		(3.10)		(−3.37)		(0.96)
SRSscore		0.226		1.414***		−0.386**
		(0.81)		(2.86)		(−2.13)
Constant	6.594***	−4.068	−20.52***	−7.837	0.198	4.814
	(7.88)	(−1.04)	(−13.51)	(−1.16)	(0.31)	(1.24)
N	782	777	776	768	788	785

t-statistics in parentheses

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

narratives. There is no significant effect on updating for either age group for inconclusive narratives.

From the regressions we observe that participants identifying as male update less than all other genders for negative narratives. When confronted with positive or inconclusive narratives, there is no difference in updating between males and all other genders. Overall, our results suggest that the beliefs of males are stickier than those of females or participants identifying as non-binary.

We also find that there is more updating after a negative narrative among those with stronger climate concerns (OpClimCh). After a positive narrative however, these subjects also become less concerned than those with weaker climate concerns. People with a higher education (the reference category is a high school degree or less) update less when confronted with a negative narrative. Note that this effect is driven by differences in prior beliefs as posterior beliefs of the more and the less educated participants are statistically indistinguishable. A corresponding reasoning also applies to the case of Republicans who, seeing a negative narrative, update more than Democrats who hold higher prior beliefs. The coefficient of the Republicans dummy is positive for the regression studying the positive nar-

ratives. Remember that here, updating is (normally) in the negative domain. Hence, upon seeing the narrative, Republicans update less than Democrats in absolute value.

3.2 Effort in the Work for Environmental Protection Task

We next turn to the effect of the narrative style and content on the willingness to engage in environmental protection, or, in the context of our experiment, on the willingness to participate in the Work for Environmental Protection Task, the number of pages attempted, and the number of pages solved in the WEPT task. Table 2 reports the share of participants agreeing to participate in the WEPT, the average number of pages attempted (=participants agreed to solve the page) and the average number of pages solved correctly for each treatment group. On average, participants correctly solved 78.2% of the pages they attempted.

Table 4 presents the results from VCE robust OLS regressions over the sample of all respondents for the treatment effects of narrative content and style on our three proxies for pro-environmental behavior, the willingness to participate in the WEPT (columns (1) and (2)),[21] the number of pages attempted (columns (3) and (4)), and the number of pages solved correctly (columns (5) and (6)). Note that the willingness to participate is a binary variable. To identify the treatment effects, we include indicator variables for the style of the narrative, its content, and an interaction term of these two variables. For the style of the narrative, the unscientific style is the reference category, while negative narratives serve as reference category for the content. In columns (1), (3), and (5), we report the regression results without further control variables and in columns (2), (4), we add control variables. Precisely, we control for the subject's initial beliefs, their age, gender, education, trust in science, political preferences, and the score on the scientific reasoning scale.[22]

As can be seen from the table, the content of a narrative does not have a significant effect on pro-environmental behavior in any of the reported regressions. Hence, the finding is robust to the inclusion of control variables. It is only for negative narratives that style matters when considering the specification with the number of pages solved as outcome variable (columns (5) and (6)). Subjects solve fewer pages having been confronted with a narrative written in the scientific style.[23] Although only significant at the 10% level, this finding suggests that the unscientific style is more powerful both in affecting beliefs and, to a lesser extent, behavior (See also Fig. 3).

The fact that the content of the narrative does not influence behavior deserves some attention. Interestingly, we find that in regressions (2) and (4), initial beliefs have a significant effect on the respective outcome variables. While we have seen above that narratives influence posterior beliefs on the harmfulness of CO_2, their impact does not appear to be sufficiently large to overrule the influence of initial beliefs on behavior. This effect is not present for the specification with the number of pages solved as outcome variable (regression (6)). The reason may be that the outcome variable – the number of pages solved – differs inherently from the other two outcome variables – the decision to participate and the

[21] The decision to participate in the WEPT is a binary decision. It indicates whether the participant agreed to continuing with the WEPT after the sample task.

[22] Note that we do not control for the participants' opinion on climate change, as it highly correlates with their initial beliefs.

[23] Considering the decision to participate in the WEPT or the number of pages attempted as outcome variables yields the same result for style when reducing the sample to those aged 45 years or older.

Table 4 OLS on decision to participate, pages attempted, and pages solved with VCE robust estimators

	(1)	(2)	(3)	(4)	(5)	(6)
	Participate	Participate	Attempted	Attempted	Solved	Solved
Incon.	0.00326	0.00367	−0.0283	0.00132	−0.277	−0.328
	(0.12)	(0.13)	(−0.10)	(0.00)	(−0.96)	(−1.15)
Pos.	0.0213	0.0262	0.0000263	0.0254	−0.323	−0.302
	(0.79)	(0.97)	(0.00)	(0.10)	(−1.12)	(−1.06)
Scientific	−0.00607	−0.00399	−0.214	−0.224	−0.476*	−0.526*
	(−0.22)	(−0.14)	(−0.78)	(−0.84)	(−1.67)	(−1.87)
Incon*Scientific	0.00398	0.000800	−0.0451	−0.0847	0.439	0.500
	(0.10)	(0.02)	(−0.12)	(−0.22)	(1.09)	(1.25)
Pos.*Scientific	−0.0274	−0.0360	0.00275	−0.0450	0.355	0.342
	(−0.70)	(−0.92)	(0.01)	(−0.12)	(0.88)	(0.86)
InitialBeliefs		0.000797**		0.00797**		0.00524
		(2.17)		(2.30)		(1.48)
Age > 45		0.0220		0.901***		0.575***
		(1.25)		(5.23)		(3.25)
Male		−0.00992		−0.398**		−0.579***
		(−0.60)		(−2.46)		(−3.44)
College		0.0381		0.0406		0.688***
		(1.49)		(0.17)		(2.81)
Bachelor		0.0549**		0.0534		0.699***
		(2.14)		(0.22)		(2.81)
Master		−0.0272		−0.364		−0.109
		(−0.88)		(−1.25)		(−0.37)
ScienceTrust		0.00168***		0.0235***		0.0150***
		(3.29)		(5.03)		(3.23)
Republican		−0.00394		0.158		0.152
		(−0.21)		(0.82)		(0.76)
Independent		−0.0221		0.130		0.256
		(−0.94)		(0.57)		(1.08)
SRSscore		0.00123		−0.00543		0.0980**
		(0.32)		(−0.15)		(2.55)
Constant	0.816***	0.594***	6.253***	3.478***	4.168***	1.500***
	(41.69)	(10.85)	(32.57)	(6.84)	(20.43)	(3.00)
N	2346	2330	2346	2330	2346	2330

t statistics in parentheses

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

number of pages attempted. While the latter two capture the willingness to engage in the task, the former also hinges to some extent on the participant's willingness to exert effort.

Result 5 *Content and style of a narrative do not have a persistent significant effect on the willingness to participate, the average number of pages attempted, and the average number of pages solved in the Work for Environmental Protection Task.*

Overall, our results in behavior also align with the well-documented attitude-behavior gap noted in other studies in the literature (Hornsey et al. 2016; Farjam et al. 2019). Interest-

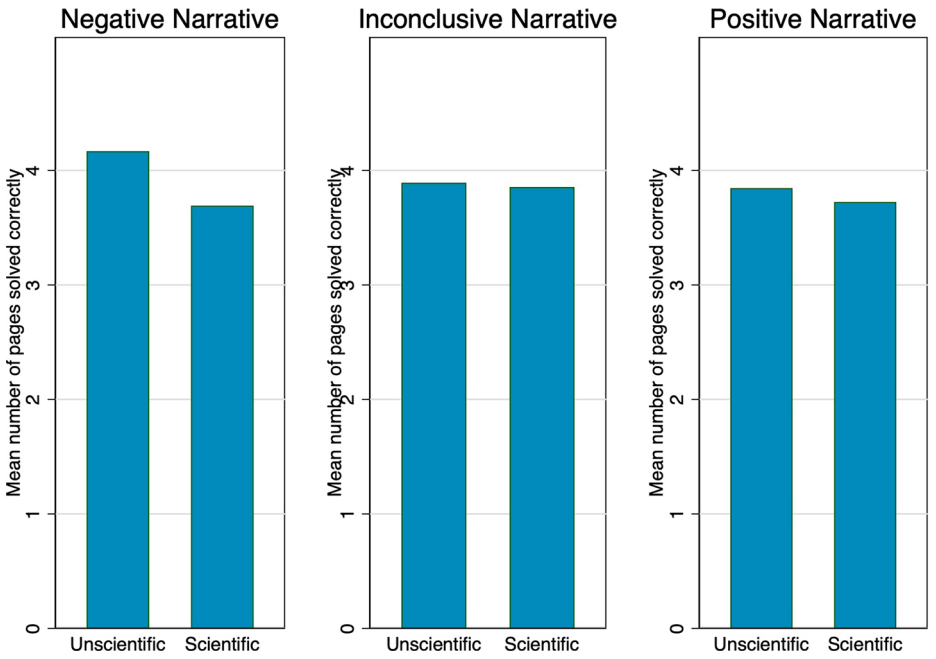


Fig. 3 Average number of pages solved correctly across treatments

ingly, this literature further notes that the link between the two is larger when the environmental behavior is framed in abstract ways (in terms of intentions for behavior) as compared to actual behavior (measured support for specific environmental policies) (Hornsey et al. 2016). Survey participants can also avoid high-cost environmental actions even when they have higher potential benefits (Farjam et al. 2019). This points to the conclusion that pro-environmental behaviors are likely to be more correlated with shifts in environmental attitudes when measured in terms of *intentions* rather than *actual behavior*. Our null result may therefore, in light of this literature, alternatively be explained by the reluctance of participants to engage in costly behavior with real-world consequences.

This conclusion naturally hinges on participants' understanding of the WEPT as a consequential task based on actual personal costs as well as real-world environmental consequences, rather than an abstract task that does not capture environmentally relevant behavior. The WEPT is widely included among a broad number of validated behavioral paradigms offering tradeoffs between personal and environmental consequences, that helps experimenters avoid the biases associated with measuring behavior through self-reported procedures (Lange et al. 2023; Lange 2023). The WEPT has been shown to be cross-culturally robust, deterred by behavioral costs, and sensitive to the scope of environmental impact (Lange and Dewitte 2023). These observations, however, come with the caveat that the arranged setting of the WEPT is not meant to reflect or measure naturally occurring pro-environmental behavior (Lange 2024). The task may serve as an experimental model, with the degree of external validity depending on the characteristics of the real-world situation that is used for comparison (Lange 2024).

4 Conclusion

To summarize, we study the effect of varying the style and content of narratives regarding CO_2 emissions generated by ChatGPT on beliefs and behavior, measured by actual effort exerted in the WEPT (Lange and Dewitte 2022). In a broader sense, we investigate if and to what extent beliefs about the harmfulness of CO_2 can be changed through AI-generated narratives, and if potential changes in beliefs materialize in changes in behavior. Whether and how beliefs and behavior can be affected through AI content is of increasing relevance for understanding nuances in critical literacy in today's digital age given the increasing presence of AI in online text (Leander and Burriss 2020).

In our online experiment, we vary both the content – stressing negative or positive aspects about CO_2 or remaining inconclusive – and the style – scientific or unscientific – of the narratives with which participants are confronted. We find that both content and style of narratives affect beliefs. When confronted with a negative narrative, participants become more concerned about the harmfulness of CO_2, and after reading the positive narrative, people become less concerned about the harmfulness of CO_2. Moreover, we find that the shift in beliefs when confronted with a positive narrative is larger in absolute value than the shift observed upon confrontation with a negative narrative. We thus find evidence for asymmetric belief updating. Secondly, we find evidence that confrontation with narratives written in an unscientific style increases polarization in beliefs. If individuals can select which narrative to read – a feature from which our paper abstracts, which is, however, very likely to be present outside our experimental context – this polarization is likely even more intense. The mirror picture of this result is that individuals update less when confronted with texts written in a scientific style.

Our findings hold relevance for scientists and policy makers alike. AI communicating information in an unscientific format increases the concern of already concerned individuals. This result complements recent research evaluating the readability and effectiveness of plain language summaries of scientific journal articles and the lack of current consensus regarding the guidelines for writing such summaries (Stoll et al. 2022). While this research establishes that plain language summaries are more readable and understandable than traditional scientific abstracts for disciplines such as psychology (Stricker et al. 2020) and medicine (Bredbenner and Simon 2019), IPCC plain language summaries of scientific articles may not be perceived as very readable (Barkemeyer et al. 2016). Our paper provides evidence that presenting information in an unscientific style can shift participants' levels of concern regarding environmental issues as well, highlighting the need for more research on the effectiveness of plain language summaries in climate communication. However, the channels through which unscientific styles have a larger (absolute) effect on belief updating than scientific styles have not fully been explored yet to date.

While we find strong evidence for both content and style of narratives impacting belief updating, neither has an effect on effort in the WEPT. Our research thus demonstrates how difficult it is to induce behavioral change in the climate domain even if decision-makers are concerned about the environment. This null effect on behavior has previously been noted in other studies attempting to measure changes in behavior (Imai et al. 2022), pointing to a need for further research on the drivers of actual environmental behavior.

Our paper takes a solid step to establish that AI interpretations of scientific and unscientific styles play a role in the persuasiveness of different narratives in climate change com-

munication. What is more, we do not only rely on AI-generated texts, but test in a pre-study if humans perceive the texts as (un)scientific as intended. Thus, we take a first step of a broader agenda in exploring how narratives of climate change can improve support for climate policies. Our results demonstrate that narratives used in science communication, through both content and style, may increase or reduce polarization of public opinion in a country.

Our results may suffer from some shortcomings inherent in the method used. As discussed, the applicability of the WEPT as a proxy for real-world pro-environmental behavior remains somewhat limited. Clearly, the WEPT and the belief elicitation questions capture decision-making in an artificial context. The question of whether the same results will be elicited with a different task remains open. Secondly, our study also has the limitation that it cannot distinguish the channel which most influences the belief-updating, whether it be emotions, narrative affect, or motivated reasoning. Moreover, our paper may also suffer from experimenter demand effects. Here, we believe that our findings on the role of style are less likely to be polluted by experimenter demand effects than our findings on the content of narratives. We ran the experiment with US subjects online, and it is unclear if the results would replicate in other cultures in lab experiments. Finally, our choice of using AI to determine the criteria for scientific narratives rather than defining it ourselves limits the possibility to predict and inform science communicators about the criteria that can influence the construction of their narratives of scientific research. We leave these open questions as promising avenues for future research.

A. Instructions and Screenshots

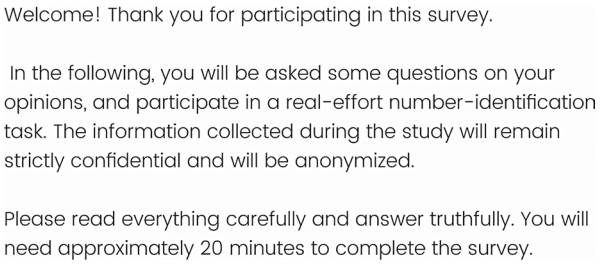


Fig. A1 Welcome screen

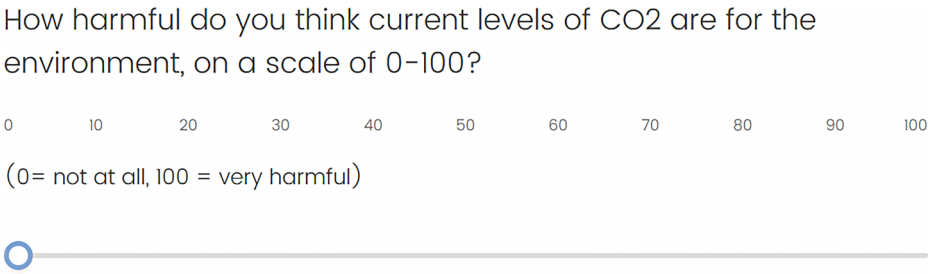


Fig. A2 Belief elicitation – identical for prior and posterior

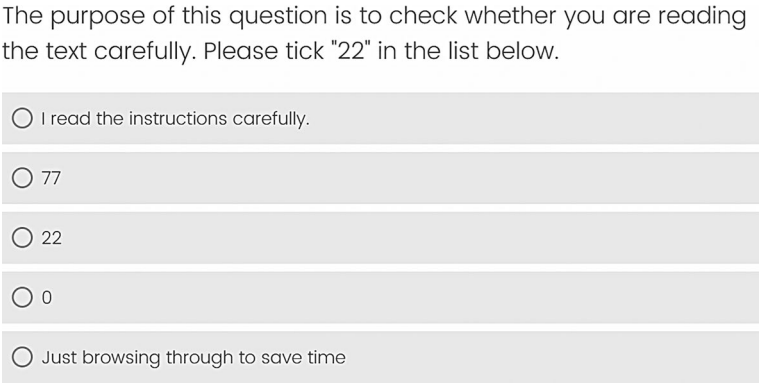


Fig. A3 Attention check

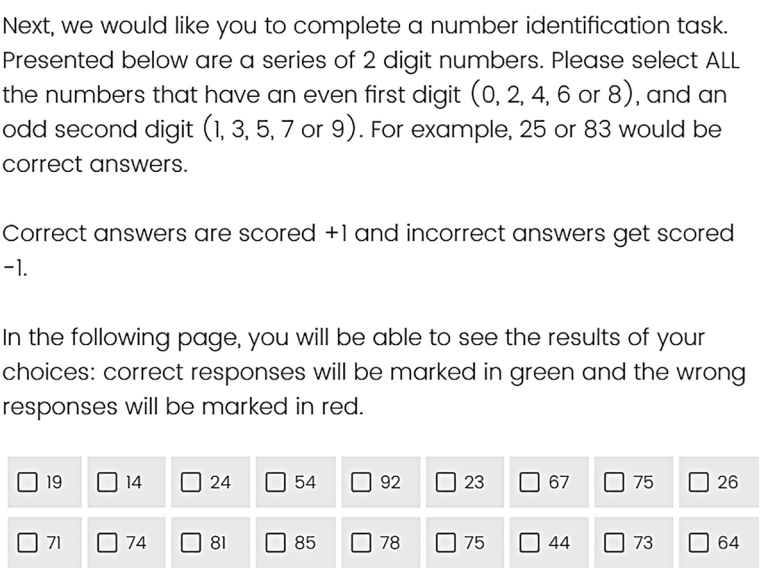


Fig. A4 WEPT: introduction

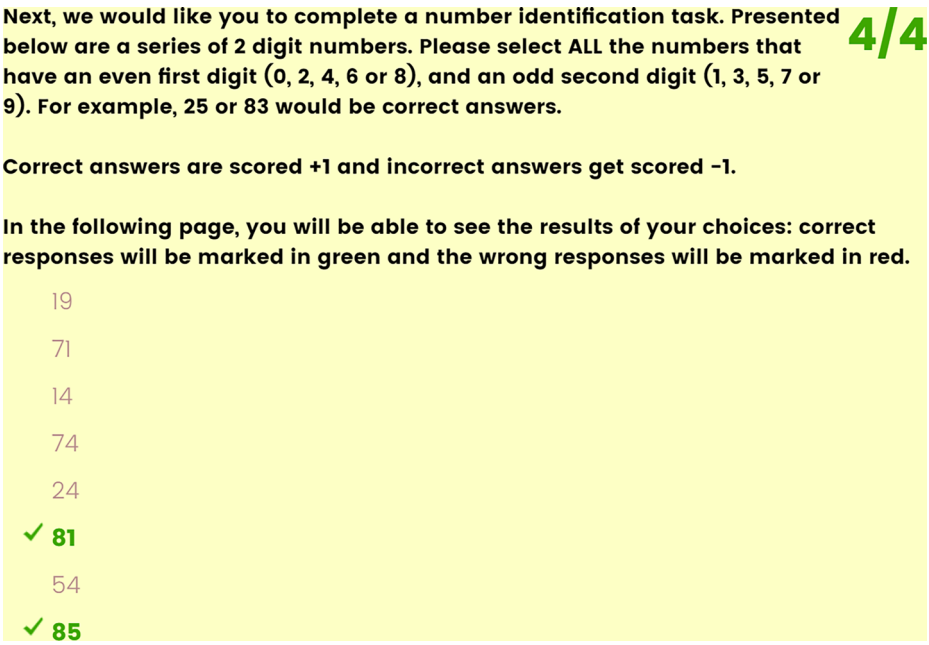


Fig. A5 WEPT: example Results

Fig. A6 WEPT: instructions

You now have the option to continue with the number identification task a little longer. In the following, we will ask you if you want to continue with additional pages of the number identification task.

For each page that you correctly complete, we (the researchers) will make a donation to the Atmosfair climate protection fund on your behalf. We will randomly select the total contribution of 1 out of every 100 respondents for the final donation to Atmosfair.

Atmosfair is a non-profit climate protection organization that works towards compensating and reducing CO2 emissions. It has diverse climate protection projects that provide 90% of the CO2 savings according to the CDM Gold Standard, the strictest available standard for climate protection projects. Atmosfair climate protection projects not only save CO2, but also promote sustainable development.

It is up to you, how much time and effort you would like to invest in the task. There are a maximum of 10 pages that you can complete.

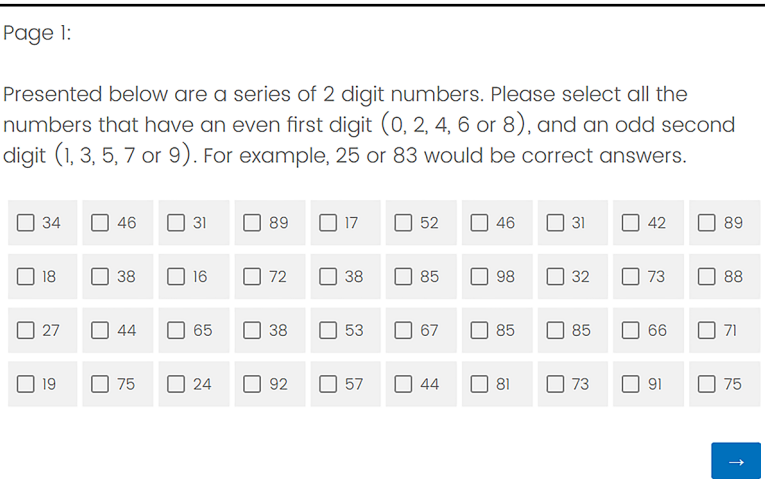


Fig. A7 WEPT: 1st page

B. Supplementary Information

B.1. Demographics

	Incon Sc	Incon UnSc	Neg Sc	Neg UnSc	Pos Sc	Pos UnSc	Total
Total	(17.1%) 400	(16.5%) 388	(16.6%) 390	(16.7%) 392	(16.5%) 388	(16.5%) 388	(100.0%) 2,346
Gender							
Non-Male	231 (57.8%)	220 (56.7%)	235 (60.3%)	226 (57.7%)	237 (61.1%)	221 (57.0%)	1,370 (58.4%)
Male	169 (42.2%)	168 (43.3%)	155 (39.7%)	166 (42.3%)	151 (38.9%)	167 (43.0%)	976 (41.6%)
Age							
≤ 45	146 (36.5%)	157 (40.5%)	140 (35.9%)	166 (42.3%)	137 (35.3%)	130 (33.5%)	876 (37.3%)
> 45	254 (63.5%)	231 (59.5%)	250 (64.1%)	226 (57.7%)	251 (64.7%)	258 (66.5%)	1,470 (62.7%)
Pol Party							
Democrat	184 (46.0%)	184 (47.4%)	205 (52.6%)	182 (46.4%)	196 (50.5%)	183 (47.2%)	1,134 (48.3%)
Republican	142 (35.5%)	139 (35.8%)	136 (34.9%)	132 (33.7%)	124 (32.0%)	127 (32.7%)	800 (34.1%)
Other	74 (18.5%)	65 (16.8%)	49 (12.6%)	78 (19.9%)	68 (17.5%)	78 (20.1%)	412 (17.6%)

B.2. Environmental Beliefs

Table B1 T-tests, content of the narrative

	Inconclusive	Negative	Positive
Initial Beliefs	63.662	63.645	64.669
Final Beliefs	64.216	69.590	46.144
Initial vs. Final Beliefs	0.2105	0.0001	0.0001
Observations	788	782	776
Initial Beliefs $<= 70$			
Initial Beliefs	42.085	42.231	40.561
Final Beliefs	44.803	53.432	28.216
Initial vs. Final Beliefs	0.0001	0.0001	0.0001
Observations	400	398	371
Initial Beliefs > 70			
Initial Beliefs	85.907	85.841	86.753
Final Beliefs	84.229	86.336	62.567
Initial vs. Final Beliefs	0.0015	0.353	0.0000
Observations	388	384	405
Age $<= 45$			
Initial Beliefs	70	70.386	71.498
Final Beliefs	72.023	74.490	59.251
Initial vs. Final Beliefs	0.0040	0.0001	0.0000
Observations	303	306	267
Age > 45			
Initial Beliefs	59.703	59.313	61.086
Final Beliefs	59.338	66.439	39.269
Initial vs. Final Beliefs	0.5196	0.0000	0.0000
Observations	485	476	509
Non-Males			
Initial Beliefs	67.978	65.679	67.583
Final Beliefs	68.678	72.926	47.703
Initial vs. Final Beliefs	0.2607	0.0000	0.0000
Observations	451	461	458
Males			
Initial Beliefs	57.887	60.726	60.471
Final Beliefs	58.243	64.797	43.899
Initial vs. Final Beliefs	0.5606	0.0000	0.0000
Observations	337	321	318

Table B2 T-tests, style of the narrative

	InCon	Neg	Pos
Updating Unscientific	0.198	6.594	−20.523
	388	392	388
Updating Scientific	0.897	5.289	−16.526
	400	390	388
Scientific vs. Unscientific	0.4290	0.2709	0.0641
Initial Beliefs $<= 70$			
Updating Unscientific	1.852	11.677	−15
	196	198	187
Updating Scientific	3.549	10.73	−9.647
	204	200	184
Scientific vs. Unscientific	0.2179	0.6278	0.0341
Initial Beliefs > 70			
Updating Unscientific	−1.489	1.407	−25.662
	192	194	201
Updating Scientific	−1.862	−0.437	−22.730
	196	190	204
Scientific vs. Unscientific	0.7238	0.0832	0.3798
Age $<= 45$			
Updating Unscientific	2.426	5.4759	−15
	157	166	130
Updating Scientific	1.589	2.4785	−9.635
	146	140	137
Scientific vs. Unscientific	0.5495	0.1467	0.1188
Age > 5			
Updating Unscientific	−1.316	7.416	−23.306
	231	226	258
Updating Scientific	0.5	6.864	−20.287
	254	250	251
Scientific vs. Unscientific	0.1093	0.6981	0.2660
Non-Males			
Updating Unscientific	0.441	7.469	−21.936
	220	226	221
Updating Scientific	0.948	7.034	−17.962
	231	235	237
Scientific vs. Unscientific	0.684	0.7729	0.1644
Males			
Updating Unscientific	−0.119	5.404	−18.652
	168	166	167
Updating Scientific	0.828	2.645	−14.271
	169	155	151
Scientific vs. Unscientific	0.4392	0.1460	0.183

C. Additional Survey Information

C.1. Narratives

Positive, scientific style Carbon dioxide (CO_2) is a necessary component for photosynthesis, the process by which plants use sunlight, water, and CO_2 to produce energy and oxygen. Increased levels of CO_2 can promote plant growth and improve agricultural yields. Additionally, CO_2 has played a crucial role in regulating the Earth's temperature over long timescales by helping to maintain stable temperatures. In conclusion, carbon dioxide (CO_2) is undeniably vital for photosynthesis, enabling plants to convert sunlight, water, and CO_2 into energy and oxygen. Moreover, higher levels of CO_2 have demonstrated the potential to enhance plant growth and agricultural productivity.

Positive, unscientific style CO_2 is like plant food, ya know? It's essential for photosynthesis, which is how plants make energy and oxygen. When there's more CO_2 in the air, it can actually help plants grow better and improve crop yields. CO_2 is also super important for the Earth's temperature. Kind of like a cozy blanket for the planet, CO_2 helps maintain temperatures that are just right for us. To wrap it up, carbon dioxide (CO_2) is like the secret ingredient plants need for their recipe called photosynthesis. It helps them take sunlight, water, and CO_2 and turn it into yummy energy and fresh oxygen. More CO_2 can actually make plants grow like crazy and make farming way more productive.

Negative, scientific style Climate change, with its increasing CO_2 levels, is affecting food chains and ecosystems worldwide. It is causing shifts in natural events such as the timing of when plants bloom or when animals migrate, resulting in mismatches in food chains. Changes in precipitation patterns affect the growth and distribution of plants, which can impact herbivores and the predators that rely on them. Changes in sea surface temperature and ocean chemistry are affecting the distribution and abundance of plankton, impacting the foundation of the ocean food chain. These impacts have significant economic consequences, including reduced crop yields and changes in the distribution and abundance of fish stock.

Negative, unscientific style Climate change, thanks to all that extra CO_2, is messing with food chains all over the world. It's making natural events happen at weird times, which is causing animals to miss out on the food they need. When plants grow differently because of changes in rain and stuff, it can mess up herbivores and the animals that eat them. When the temperature of the ocean water goes up and the chemicals in it change, it messes with the little guys called plankton, which can mess up the food chain there too. These changes are causing problems for people too, like less food to go around and changes in the types of fish we can catch.

Inconclusive, scientific style Some studies suggest that solar variations might have had some influence on regional climate patterns in the past, particularly during periods which corresponded to colder temperatures in parts of Europe. The belief that the sun plays a significant role in causing climate change is grounded in the understanding that variations in solar activity can influence Earth's climate. Proponents of this belief suggest that periods of

increased solar activity can result in higher levels of solar radiation reaching the Earth, leading to warming trends. Conversely, periods of decreased solar activity correspond to cooler climatic conditions. With studies suggesting that solar variations may have had influence on regional climate patterns in the past, the role of CO_2 in causing climate change remains a subject of ongoing scientific inquiry.

Inconclusive, unscientific style You won't believe what some studies have found! They say that solar variations might have messed with the climate in the past, especially in Europe where things got colder. The sun may be messing with our weather. Some people believe that the sun has a hand in climate change because changes in solar activity can affect Earth's climate. They think the sun's behavior can mess with our weather down here. When the sun gets all active, it pumps out more of its rad solar radiation. And that extra heat makes the Earth get al.l toasty, making things warmer. When the sun decides to chill out and take a break, it makes things cool down. So basically, the studies say that the sun's mood swings might have messed with the weather in different parts of the world before. And so the whole idea that CO_2 is responsible for climate change is still up in the air.

C.2. Perception of the Narratives in the Pre-Study

In the pre-study, we tested how participants perceived the different AI-generated narratives. More precisely, we asked them for a rating on a scale from 0 to 100 for the following dimensions: i) whether the writing style is perceived as scientific, ii) whether the content is perceived as scientific, iii) whether the arguments are perceived as scientific, iv) whether the narrative is perceived as credible, v) whether the narrative is consistent with the subjects' prior knowledge, and vi) whether the narrative is perceived as being certain about the stated facts. Recall that we only vary the writing style while keeping the content of the narratives constant. Indeed (and as intended), subjects perceive the writing style of the scientific narratives as more scientific than of the unscientific narratives (two-sided t-test for the positive narratives: 73.047 vs. 57.153, $p < 0.001$, for the inconclusive narratives: 66.931 vs. 50.281, $p < 0.001$, and for the negative narratives 73.368 vs. 57.742, $p < 0.001$). However, they also perceive the content and the arguments as significantly more scientific when the writing style is scientific. Moreover, scientific narratives are perceived as more credible, as more consistent with prior knowledge, and as more certain about the facts. These results are surprising since, apart from the writing style, the narratives are identical.

It might be the case that some narratives have a stronger influence on beliefs because they are perceived as more credible, more consistent with prior knowledge, or more scientific. To investigate this channel, we compare the perceptions of the narratives across the six above-stated dimensions. When pooling over both writing styles, we find no statistically significant differences between positive and negative narratives in any of the six dimensions. When comparing the positive with the inconclusive narratives, we observe that the content of the positive narrative is perceived as more scientific (two-sided t-test: 72.813 vs. 67.360, $p = 0.052$), it is perceived as more consistent with prior knowledge (two-sided t-test: 68.773 vs. 61.293, $p = 0.019$), and it is perceived as more certain (two-sided t-test: 73.880 vs. 66.707, $p = 0.025$). When comparing the negative with the inconclusive narratives, the result is similar. We find that the negative narratives appear to be more consistent

with the subjects' prior knowledge (two-sided t-test: 70.655 vs. 65.845, $p = 0.085$) and more certain (two-sided t-test: 75.333 vs. 69.476, $p = 0.019$).

Considering the scientific and the unscientific narratives separately, our main result remains the same: There are no statistically significant differences in the perception of negative and positive narratives in any of the six dimensions considered. In the comparisons between the positive and the inconclusive narratives, the positive narrative is perceived as superior in some, but not all of the dimensions – both when considering the scientific and the unscientific narratives. The same finding applies to the comparison of negative and inconclusive narratives where the negative is perceived as weakly superior. The finding that negative and positive narratives reach statistically indistinguishable scores is particularly interesting in light of the result on valence asymmetry: Even though the perception is indistinguishable, they affect beliefs differently. Hence, another channel must drive the differences in belief updating.

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