Consensus Messaging in Climate Change Communication: Metacognition as Moderator Variable in the Gateway Belief Model

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Abstract

The issue of anthropogenic climate change is one of the most pressing challenges for society. Thus, the development of efficient strategies to increase the public's awareness of climate change is essential. Previous research has shown that one such strategy, consensus messaging, can correct peoples' misconceptions about their estimation of scientific consensus concerning climate change and increase, for example, their support for measures against global warming. Given the importance of developing reliable strategies, understanding the circumstances under which consensus messaging does and does not work is crucial. Thus, the present study investigated confidence in perceived scientific consensus (PSC) as a moderator variable in the consensus messaging process, using a national representative US sample (*N* = 898). More specifically, we investigated the role of confidence in PSC for (i) the debiasing process, i.e., the integration of the consensus message into the estimation of scientific consensus, and (ii) the updating process of climate change attitudes (belief in climate change, worry about climate change, and human causation of climate change). Results showed that confidence in PSC significantly predicts how much participants updated their PSC toward the consensus. We replicated those results for a high-consensus country (*N* = 1110, representative German sample). Furthermore, confidence in PSC played a moderating role in updating participants' beliefs in the human causation of climate change. Our findings suggest climate change related metacognition to be an important factor explaining the formation and updating of corresponding beliefs and highlight the importance of considering metacognitive aspects of climate change communication strategies.

Introduction

Consensus messaging is one of several communication strategies aiming at increasing the public's climate change awareness (e.g. van der Linden et al., 2015; Bayes et al., 2020). Central to this strategy is the assumption that the public does not have accurate knowledge about the degree of scientific consensus on anthropogenic climate change. Even though climate change scientists are not divided on whether climate change is man-made, and the vast majority of scientists agrees on its anthropogenic cause (Cook et al., 2013, 2016; Powell, 2015), this scientific agreement is still severely underestimated by the public. To correct this misconception, the core idea of consensus messaging is to provide participants with accurate information communicated via a descriptive norm, a statement like “97% of climate scientists have concluded that human-caused global warming is happening”. According to the gateway belief model (van der Linden et al., 2015; also see Bayes et al., 2020; Landrum & Slater, 2020; van der Linden, 2021; review papers), the estimation of scientific consensus (perceived scientific consensus; PSC) acts as a “gateway belief” which is an important determinant of other key beliefs about climate change. The presentation of a consensus message can then increase an individual’s PSC in the so-called debiasing process, which should induce further changes in other climate change related attitudes.

A substantial number of studies show that consensus messaging can positively impact both PSC and, subsequently, further climate change attitudes (e.g. Brewer & McKnight, 2017; Cook & Lewandowsky, 2016; Deryugina & Shurchkov, 2016; Ding et al., 2011, correlational evidence; Goldberg et al., 2019; Lewandowsky et al., 2013; McCright et al., 2013, correlational evidence; van der Linden et al., 2015). In two meta-analyses it was shown that consensus messaging seems to be significantly related to changes in climate changes attitudes besides PSC, even though effects were relatively small (Rode et al., 2019; van Stekelenburg et al., 2020).

However, a growing body of research on consensus messaging show that results are more mixed: In some cases, the gateway belief model was only partially replicated. For example, Bolsen and Druckman (2018) found an effect of consensus messaging on some of the climate change attitudes for specific partisan subsamples (for example, consensus messaging increased the belief in human-

causation of climate change for low-knowledge and high-knowledge Democrats as well as low-knowledge Republicans) but not for the whole sample. Other research found that consensus messaging solely increased the PSC with no effect on any of the climate change attitudes (Dixon et al., 2017; Kerr & Wilson, 2018; Rode et al., 2021; Said, Frauhammer, et al., 2022; Tschötschel, 2021).

Moderator Variables in the Gateway Belief Model: The Influence of Metacognition

Given the inconclusive results on the effectiveness of consensus messaging, *determining under which conditions it works and what might be hampering its effectiveness is crucial.* Albeit research on possible moderating variables is still sparse, there is some research showing that interest in climate change, political ideology, and prior beliefs about climate change do play a role concerning the effectiveness of consensus messaging (Brewer & McKnight, 2017; Cook & Lewandowsky, 2016; van der Linden et al., 2019). Van der Linden et al. (2019), for example, showed that conservative participants also had a higher likelihood of integrating the consensus message into their belief than less conservative participants.

In the current study we want to investigate peoples' climate change related metacognition as moderator variable. As has been shown in recent research, peoples' metacognitive abilities are linked to beliefs as well as belief formation in political and societal topics (Fischer & Said, 2021; Rollwage et al., 2018; Said et al., 2021; Sanbonmatsu et al. 2018; Tsakiris et al., 2021), making them a promising candidate to investigate. Thus, the current study explores the possible moderating effect of one facet of metacognition, that is, people's *confidence* in their climate change knowledge within the gateway belief model. Since knowledge about the scientific consensus is the key variable in the gateway belief model, we especially focus on the participants' PSC and confidence therein[1]. More specifically, we investigate the role of confidence in one's estimate of the scientific consensus with respect to (i) updating the PSC toward the consensus and (ii) updating climate change attitudes.

1 It is important to point out that we tried to distinguish between the PSC and the subsequent climate change *attitudes*. While both PSC and climate change attitudes could be seen as *beliefs* about climate change, PSC also encompasses *a specific piece of knowledge*, namely that 97% of scientists agree that climate change is man-made. This distinguishes it from attitudes like support for climate change and worry about climate change. Even though belief in global warming and human causation of climate change could also be seen as either true or false knowledge, the way participants were asked made it very clear that we asked about a belief and not a piece of knowledge (see A1 in the appendix).

***Updating Perceived Scientific Consensus*[2].** So far, a substantial body of research already exists proposing that confidence in one's beliefs might play an essential role concerning integration of new information (Dole & Sinatra 1998; Heckerman & Jimison, 2013; Pintrich et al., 1993; Savion, 2009). Pintrich et al., (1993) suggested that individuals with higher confidence in their prior beliefs might be less willing to engage with information that is contradictory to those beliefs. Unwarranted (over-)confidence in one's belief decreases the likelihood of changing that belief even if contradicting information is presented (Pintrich et al., 1993; Savion, 2009). On the other hand, recent research has shown that uncertainty about the beliefs one holds makes one more likely to change those beliefs in case of new information (Orticio et al., 2021). Thus, we propose that confidence in perceived scientific consensus should also predict evidence integration in the consensus messaging process. Referring to the gateway belief model, we expect confidence in PSC to moderate the debiasing process, i.e., the integration of the consensus message into the estimation of scientific consensus. Additionally, we want to explore whether there is a relationship between participants' evidence integration and confidence in their PSC *after* they receive the consensus message. Investigating whether or not there is a correlation between updating the PSC towards the consensus and how confident people are in their new estimation might give us additional insight into the effectiveness of the consensus message. Ideally, the consensus message should influence peoples' estimate of the PSC and their confidence in this estimate. As discussed above, higher confidence in one's belief makes it less likely to change such a belief (Pintrich et al., 1993; Savion, 2009). As people are usually confronted with a noisy and confusing information environment (especially in the case of climate change), high confidence in the new estimate might counteract the influence of contradicting information. Even though our study is not designed to investigate the long-term effects of consensus messaging, exploring whether post-treatment PSC and confidence are related might give us some valuable first insight.

2 Note, that the subsection „Updating Perceived Scientific Consensus" was not part of the pre-registration.

Updating Climate Change Attitudes. Even though literature within the context of climate change specifically is still sparse, there are some studies linking confidence in climate change knowledge and beliefs about climate change: For example, Fischer and Said (2021) showed that people having higher confidence in their climate change knowledge were more likely to believe in the existence and anthropogenic cause of climate change. This suggests that confidence in one's knowledge might be an important predictor as to whether this knowledge translates into corresponding beliefs. Based on this argument, Said, Frauhammer et al. (2022) investigated whether participant's confidence in the accuracy of their estimation of the scientific consensus moderates the relationship between PSC and climate change attitudes in a representative German sample. Even though there was no moderating effect of confidence in PSC on the relationship between PSC and climate change attitudes, it is important to note that this study found no association between PSC and climate change attitudes. Thus the lack of a significant interaction effect does not seem surprising. Thus, *given that there is a relationship* between PSC and climate change attitudes, we expect that higher confidence in PSC enhances the relationship between PSC and climate change attitudes.

Present Study. The aim of the present study is to investigate the role of confidence in one's estimate of the scientific consensus on the two stages in the gateway belief model: we expect that confidence in one's PSC influences the (i) updating process of participants' perceived scientific consensus and (ii) the updating process of participants' climate change attitudes.

Methods

This study was preregistered under: https://aspredicted.org/R4V_8XT. Furthermore, the study was approved by the local ethics committee of the Leibniz-Institut für Wissensmedien. Data and R script can be accessed via (OSF Link will be provided here).

Participants

In total *N = 1,094* participants completed the study. The sample was *national representative* for the US population with respect to age and gender and was collected via the online polling company *Bilendi*. In total *N = 898* participants passed the attention check and were included in the analysis. *N = 451* participants were in the control group and *N = 447* in the experimental group. *N = 451*

participants were female, *N = 443* participants male, and *N = 4* non-binary[3]. Mean age was 47.24 years (*SD =15.29 years*). With respect to political party, 28.06% identified as Republican, 39.31% as Democrat, and 32.63 % as Independent. Furthermore, we assessed political ideology ranging from 1 (very conservative) to 5 (very liberal). Mean ideology score was 2.96 (SD = 1.07). With respect to education level, 1.11% of participants reported having an education level less than high school, 34.63% high school, 37.75% Bachelor (or equivalent), 16.37% Master (or equivalent), 2.12% reported having a PhD, and 8.02% responded to the question with "other".

Power analyses

A power-analysis showed that our final sample size was large enough to replicate prior results regarding the group difference in PSC with large statistical power ($\alpha_{revised}$ = 0.01, *d* = 0.88, 1 - $\beta = 0.\overline{9}$), and the group difference in belief in human causation with sufficient statistical power ($\alpha_{revised}$ = 0.01, *d* = 0.23, 1 - β = 0.81; effect estimates are taken from van der Linden et al., 2019; power analyses conducted with G*Power, Faul et al., 2007). However, our sample size was not large enough to replicate van der Linden et al.'s (2019) results on the other climate change attitudes with acceptable statistical power. Our decision to settle for a total sample size of *N* = 1000 (see pre-registration) was made due to economical reasons (for a full replication *N* = 5000 - 6000 participants would have been needed). For the purpose of our study however, showing that consensus messaging has an effect on one climate change attitude is sufficient.

Stimuli and Measures

Climate Change Attitudes and Perceived Scientific Consensus. To assess climate change attitudes, participants were asked about their belief in climate change, their belief in the anthropogenic cause of climate change, how much they worry about climate change, and their support for action against climate change on a 7-point scale ranging from 1 (lowest endorsement) to 7 (highest endorsement). Items were taken from van der Linden et al. (2019). The specific answer scales for each attitude are displayed in Table A1 in the appendix. To measure the perceived scientific consensus a continuous

3 Due to the very low number of participants in the non-binary category, we randomly assigned them to either "female" or "male" to facilitate analyses.

scale ranging from 0% - 100% was used. Confidence in PSC was measured by asking participants “how certain are you about your estimation?“ on a continuous scale ranging from 50% - 100%.

Procedure

The same procedure as in van der Linden et al. (2019) was used. Additionally, climate change knowledge and confidence in climate change knowledge items were included (those items are not reported in the main manuscript, for further information see Appendix A6). The experiment was carried out under the pretense of assessing the public opinion about different topics. It started with three blocks of questions on different topics. One of these blocks consisted of the questions on climate change attitudes, PSC, and the climate change knowledge test described above. The other two blocks contained bogus questions on artificial intelligence and some technological products. These questions were included to mask the true purpose of the study. Like the climate change block, the two bogus blocks also contained questions on the participants’ personal beliefs as well as knowledge and confidence questions. The three blocks were presented in randomized order.

In a next step the consensus message was shown to participants in the experimental condition. Therefore, they were told that they would see a media statement randomly drawn from a large database of such statements and were asked to read this statement carefully. Afterwards participants received the following consensus message: *97% of climate scientists have concluded that human-caused global warming is happening*. To ensure that all participants read the consensus message, reaching the next slide of the questionnaire was only possible after a delay of 4 seconds. Participants in the control group did not see the consensus message but instead completed the cognitive reflection test, a short cognitive task consisting of three items (Frederick, 2005). Thereafter, all participants answered four additional bogus questions on the Academy Awards ceremony. Finally, the participants again answered the questions about climate change attitudes and PSC as well as the questions on personal beliefs from the two bogus blocks. The knowledge questions were not presented a second time. Again, the three blocks were presented in randomized order. Lastly, participants were asked to provide some demographic information and were debriefed about the

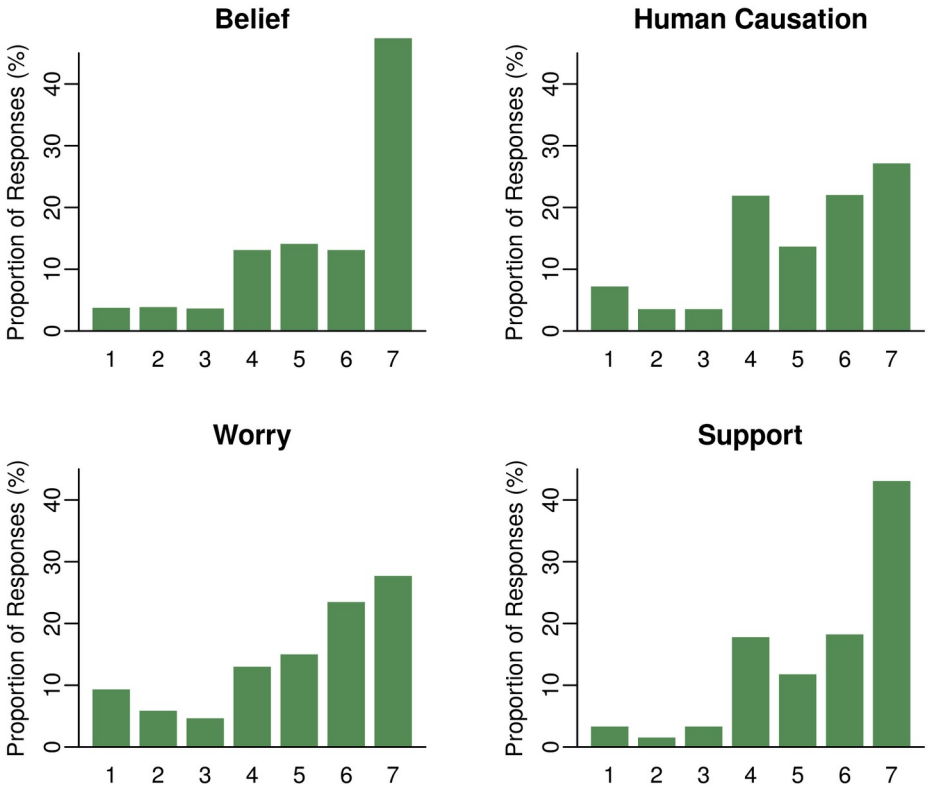
true purpose of the study. They then received the opportunity to disagree to the processing of their data.

Results

Descriptive results. Means, standard deviations, and correlations of pre-treatment climate change attitude are displayed in Table A1 in the appendix. Participants' pre-treatment climate change attitudes are displayed in Figure 1. The perceived scientific consensus was $M_{pre\_control} = 73.07$ ($SD_{pre\_control} = 21.65$) for the control group and $M_{pre\_experimental} = 71.44$ ($SD_{pre\_experimental} = 22.47$) for the experimental group. While there was no change for the control group $M_{post\_control} = 72.74$ ($SD_{post\_control} = 22.26$), $t_{control}(899.32) = 0.22$, $p_{control} = .824$, for the experimental group the estimated perceived scientific consensus was significantly higher after the message $M_{post\_experimental} = 83.85$ ($SD_{post\_experimental} = 20.76$), $t_{experimental}(886.49) = -8.57$, $p_{experimental} < .001$.

Figure 1

Pre-Treatment Climate Change Attitudes (belief in climate change, belief in human-causation of climate change, worry about climate change, and support for action)

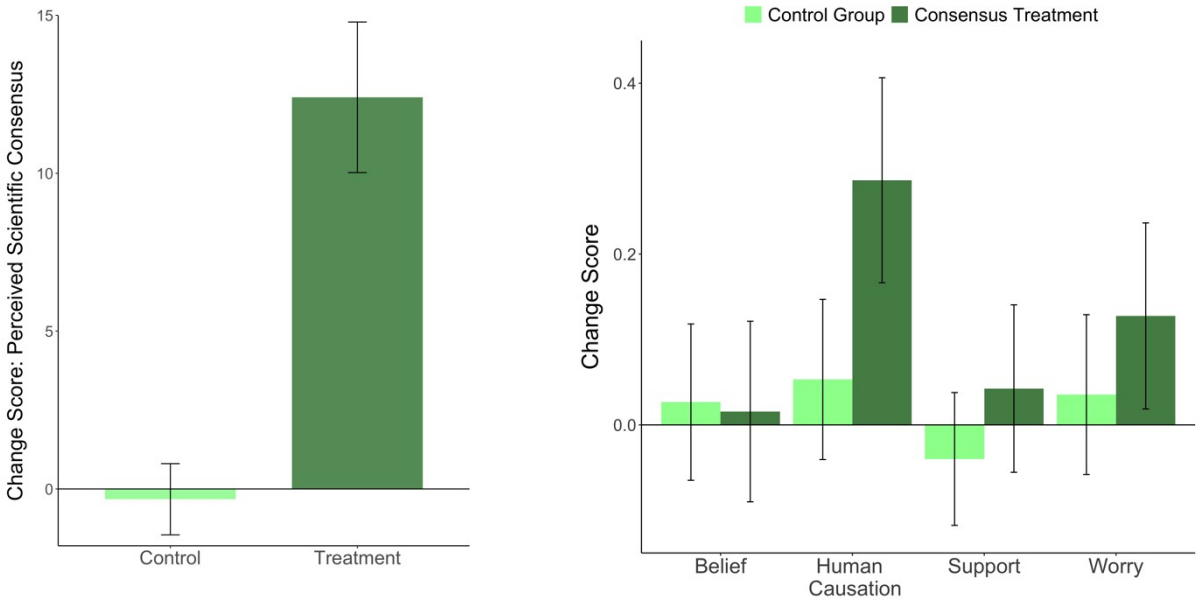


Note. Responses ranged from 1 (lowest endorsement) to 7 (highest endorsement).

In a first step a MANOVA was conducted to investigate whether the consensus message had an influence on the change scores (post – pre) of any of the five variables of interest (perceived scientific consensus, belief in climate change, human causation, worry about climate change, and support). Results showed a significant difference of the change scores between the two conditions: $F(5, 892) = 33.88$, $p < .001$, Wilk's $\lambda = 0.84$. Thus, in a second step, univariate Welch t-tests were conducted. Note, that results displayed below are Bonferroni corrected with an adjusted alpha-level of $\alpha = .05/5 = .01$. Results showed that there was a significant effect of experimental condition on PSC, $t_{PSC}(636.5) = -12.49$, $p_{PSC} < .001$, $d_{PSC} = 0.83$ and on human causation $t_{HumanCausation}(844.7) = -3.96$, $p_{HumanCausation} < .001$, $d_{HumanCausation} = 0.26$. There was no significant effect on any of the other climate change attitudes, $t_{Belief}(876.7) = 0.20$, $p_{Belief} = 0.840$, $t_{Worry}(874.8) = -1.66$, $p_{Worry} = .097$, and $t_{Support}(850.2) = -1.70$, $p_{Support} = .089$. Figure 2 displays the change scores of PSC as well as the climate change attitudes.

Figure 2

Mean Change Scores of Perceived Scientific Consensus (left) and Climate Change Attitudes (right)



Note. Error bars represent the 99% confidence interval.

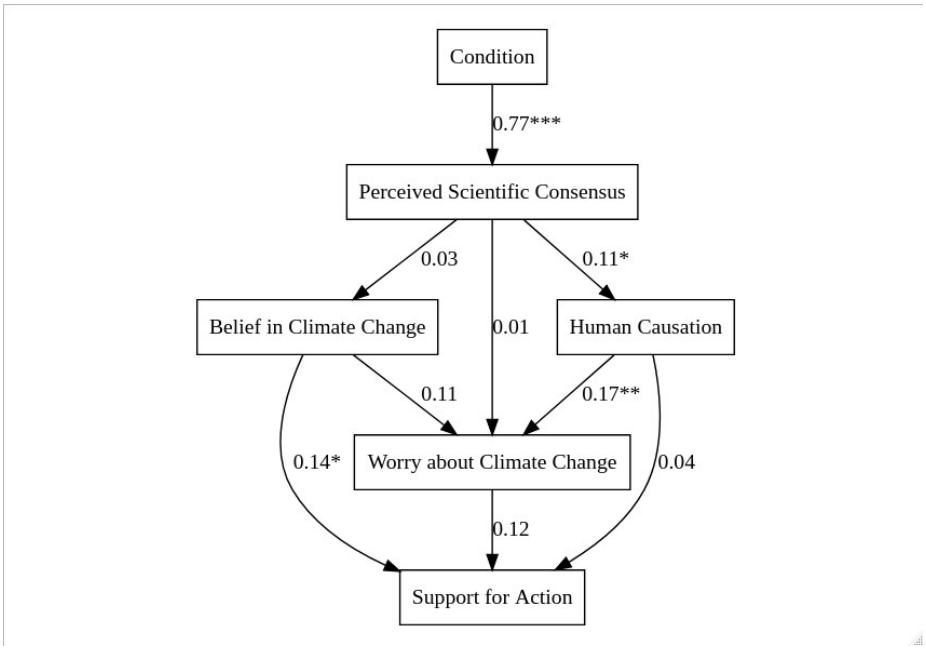
Mediation Analyses

To investigate the two-stage mediational structure of the gateway belief model a mediation analysis was conducted. For computation the R-package lavaan was used (number of bootstraps $n = 5000$).

Results showed that there was a significant direct effect of PSC on belief in human causation of climate change (see Figure 3 and Table A4.1 in the appendix)[4].

Figure 3

Mediation Analysis



Note. Standardized change scores of all dependent variables are displayed. *p < .05; **p < .01 ; ***p < .001. N = 898. Model fit: χ^2 (6) = 45.42, p < .001, RMSEA = .086 (90% CI: .063 - .110), CFI = 0.86.

Moderation Analyses

Updating PSC: The Role of Confidence in Perceived Scientific Consensus. We exploratory[5] conducted two regression analyses with the change score of PSC as dependent variable and 1) confidence in pre-treatment PSC and (2) confidence in post-treatment PSC as well as experimental condition as independent variables, testing for the interaction between either (1) or (2) and experimental condition. The following control variables were included in the models: gender, age, education, political ideology, and pre-treatment PSC. Both, the main effects of the aforementioned control

4 Climate change attitudes did not mediate any of the indirect effects of the PSC on support for action (see Table A4.2 in the appendix). Furthermore, results did not change even when age, gender, education, and ideology were included as control variables (see Table A5.1 and A5.2 in the appendix). To include education as control variable, the levels had to be transformed to continuous values. This was done by setting the category "other" to zero.

5 Note, that we pre-registered metacognitive sensitivity to play a moderating role with respect to the updating process. As results were not significant we moved the analysis to the appendix (see A6).

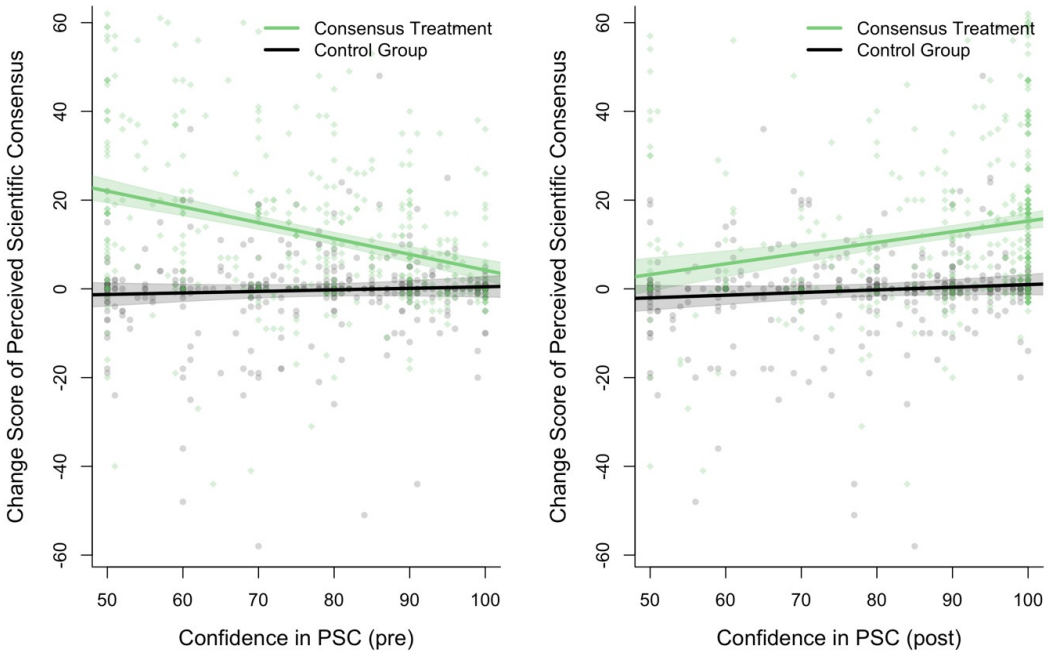
variables together with their interactions with the experimental condition were included (as recommended by Yzerbyt et al., 2004).

For both analyses there was a significant interaction effect between experimental condition and the pre-treatment PSC: $F_{(1)}(21, 876) = 24.07$, $p_{(1)} < .001$, $R_{(1)}^2 = .37$, $R_{(1)}^2{}_{\text{Adjusted}} = .35$, $b_{(1)\text{PSC}} = -0.39$, $t_{(1)PSC}(876) = -6.23$, $p_{(1)PSC} < .001$. $F_{(2)}(21, 876) = 40.12$, $p_{(2)} < .001$, $R_{(2)}^2 = .49$, $R_{(2)}^2{}_{\text{Adjusted}} = .48$, $b_{(2)\text{PSC}} = -0.62$, $t_{(2)PSC}(876) = -11.02$, $p_{(2)PSC} < .001$. That is, those who received the consensus message adjusted their PSC more towards the consensus the lower their initial estimation of the PSC was. Additionally the interaction between ideology and experimental condition was marginally significant for the first (confidence in pre-treatment PSC): $b_{(1)\text{Ideology}} = -0.11$, $t_{(1)Ideology}(876) = -1.90$, $p_{(1)Ideology} = .058$ and significant for the second analysis (confidence in post-treatment PSC): $b_{(2)\text{Ideology}} = -0.11$, $t_{(2)Ideology}(876) = -2.11$, $p_{(2)Ideology} = .035$. More specifically, participants with more conservative view adjusted their PSC more toward the consensus.

More importantly, the interaction effects between (1) confidence in pre-treatment PSC and (2) confidence in post-treatment PSC and experimental condition were significant as well: There was a negative interaction between confidence in pre-treatment PSC and experimental condition: $b_{(1)\text{Confidence}} = -0.19$, $t_{(1)Confidence}(876) = -3.18$, $p_{(1)\ Confidence} = .0015$, suggesting that participants who were more confident in the accuracy of their pre-treatment PSC did adjust their post-treatment PSC less (see Figure 4, left). There was a positive interaction between confidence in post-treatment PSC and experimental condition $b_{(2)Confidence} = 0.49$, $t_{(2)Confidence}(876) = 8.61$, $p_{(2)\ Confidence} < .001$, participants who were more confident in the accuracy of their post-treatment PSC did also adjust their post-treatment PSC more (see Figure 4, right).

Figure 4

Moderation Analysis



Note. Plots show the analysis results without the control variables (gender, age, education, and political ideology) to simplify the graphical illustration.

The analyses described above operationalized evidence integration as the change score of PSC. This approach has two shortcomings. First, the change score of PSC is strongly dependent on the pre-treatment PSC in the way that participants, who indicated a high PSC before reading the consensus message cannot have a high change score, as the estimate can only reach 100%. A complete evidence integration, however, exists whenever the post-treatment PSC is 97%, independent of the pre-treatment value. Second, this analysis is not suitable for dealing with negative change scores, i.e., participants whose post-treatment PSC was lower than their pre-treatment PSC. To make sure that our results were not distorted by these shortcomings, we

conducted additional analyses using a relative measure of evidence integration. We therefore calculated the extent to which the participants updated their PSC toward the communicated percentage of 97%, relative to their pre-treatment PSC, using the following formula:

$$Relative\ Change = |97\% - PSC1| - |97\% - PSC2| / |97\% - PSC1|$$

Using the *relative change* score we calculated the regression analysis described above again, controlling for gender, age, education, political ideology, and pre-treatment PSC. Participants whose pre-treatment PSC was exactly 97% (n = 28), as well as participants whose relative change value reached extreme values (deviation greater than 2 SD from the mean; n = 9) were excluded from this analysis. The results of this regression analysis corresponded to the results obtained with the simple change scores. The interaction effect between confidence in pre-treatment PSC and experimental condition was again significant: $F_{(1)}(21, 839) = 15.18$, $p_{(1)} < .001$, $R_{(1)}^2 = .28$, $R_{(1)}^2{}_{Adjusted} = .26$, $b_{(1)\ Confidence} = -0.20$, $t_{(1)Confidence}(839) = -3.05$, $p_{(1)\ Confidence} = .002$. That is, higher confidence in pre-treatment PSC led to a lower adjustment of the PSC toward the consensus in the experimental group. The interaction effect between confidence in post-treatment PSC and experimental condition was also significant: $F_{(2)}(21, 839) = 25.28$, $p_{(2)} < .001$, $R_{(2)}^2 = .39$, $R_{(2)}^2{}_{Adjusted} = .37$, $b_{(2)Confidence} = 0.44$, $t_{(2)\ Confidence}(839) = 7.10$, $p_{(2)\ Confidence} < .001$. That is, there was a positive relationship between PSC adjustment towards the consensus and confidence in post-treatment PSC in the experimental group. Note that for the relative change score the interaction between ideology and experimental condition was not significant for both analysis: $b_{(1)Ideology} = -0.02$, $t_{(1)Ideology}(839) = -0.25$, $p_{(1)Ideology} = .801$ and $b_{(2)Ideology} = -0.02$, $t_{(2)Ideology}(839) = -0.27$, $p_{(2)Ideology} = .790$.

Taken together, for both scores (change score and relative change score) results show that confidence in ones' own estimate of the PSC does play a role in evidence integration.

Replication with a representative German sample. Additionally we re-analyzed the data of Said, Frauhammer et al. (2022) replicating the results of the analyses above for both types of scores (see appendix A7) for a high-consensus country.

Updating Climate Change Attitudes: The Role of Confidence in Perceived Scientific Consensus.

Multiple regression analyses were conducted to test whether there is an interaction between post-treatment PSC and confidence in PSC for the change scores of three different measures: belief in climate change, belief in human causation, and worry about climate change (for the analysis all scores were standardized; support for action was not part of the pre-registered analyses since it should not be directly influenced by PSC). In all analyses age, gender, education, and political ideology were added as control variables. Furthermore, we also controlled for experimental condition as well as pre-treatment attitudes. Note, that results for the regression analysis are Bonferroni corrected with an adjusted alpha-level of $\alpha = .05/3 = .017$. Results showed that there was a positive interaction between post-treatment PSC $_{\text{post-treatment}}$ and confidence in PSC$_{\text{post-treatment}}$ on belief in human causation: $F(23, 874) = 8.358$, $p < .001$, $R^2 = .18$, $R^2_{Adjusted} = .16$, $b_{PSCxConfidence} = .08$, $t_{PSCxConfidence}(874) = 2.41$, $p_{PSCxConfidence} = .016$. When comparing the model including the interaction term between pre-treatment PSC and confidence in PSC with the baseline model only containing the covariates results showed that the interaction term is predictive above and beyond the baseline model ($\Delta R^2 = .006^*$, 95% CI[-.00, .01]). Thus, participants who were more confident in their post-treatment PSC estimate also updated their belief in human-causation more. Results of the multiple regression analyses for all three measures can be found in Tables A8-A10 in the appendix.

Discussion

The aim of our study was to investigate the role of confidence in one's estimate of scientific consensus on (i) updating the PSC toward the consensus and (ii) updating climate change attitudes. Note that throughout the discussion when the terms "updating", "changing" or "adjusting" are used, this always refers to a change in the positive direction (toward the consensus/higher belief in man-made climate change etc.).

Updating PSC: Confidence in Perceived Scientific Consensus as Moderator

Results showed that confidence in one's estimate of the PSC plays a role in evidence integration in two ways: first, high confidence in prior estimates of the PSC seems to hinder updating the PSC toward the consensus. Second, high confidence in PSC after the intervention was related to a more

considerable change in participants' initial estimate of the PSC. To tackle the problem that the change scores of the PSC are (i) strongly dependent on the participants' prior estimations of the PSC and (ii) contain negative values for participants who changed their PSC in the opposite direction, we conducted an additional analysis calculating a *relative change score*. Although the effects were slightly smaller in this additional analysis than in the original analysis, the same pattern was replicated, thus corroborating our findings. Furthermore, we replicated van der Linden et al. (2019) findings for the second analysis (interaction between confidence in post-treatment PSC and condition) in that participants who reported being more conservative also had a higher likelihood to update their beliefs toward the consensus. Like van der Linden et al. (2019) we did find that conservatives had a lower PSC baseline (63%) than liberals (77%), thus our finding could be explained by a ceiling effect. This is further substantiated by the fact, that we did not replicate this interaction for the relative change score. That is when taking participants' prior estimations of the PSC into account, political attitude did not play a role anymore.

Finally, we replicated our results for high-consensus country with data from a representative German sample (Said, Frauhammer, et al., 2022). This corroborates our results in an important way as a cross-cultural replication shows the generality of our results.

High confidence in prior PSC. Our first analysis showed that high confidence in the initial estimate of the PSC is detrimental to the updating process. Participants who were already confident that their assessment of the PSC was correct were *less likely* to integrate the consensus message. This is in line with previous research, suggesting that high confidence in prior beliefs leads to *belief perseverance* (Pintrich et al., 1993; Savion, 2009) and lower confidence leads to a higher willingness to adjust prior beliefs (Orticio et al., 2021). Given that people with anti-consensus scientific beliefs are prone to be more overconfident regarding their knowledge (Light et al., 2022), our finding is of high relevance as it shows that even though consensus messages can correct false prior knowledge or beliefs unwarranted confidence in prior knowledge limits its effectiveness. However, there is also research showing that high confidence in prior knowledge does not necessarily hinder the integration of new

information when taking other factors, like self-efficacy, scientific understanding, and interest[6] into account (Cordova et al., 2014). Thus, to better understand the driving factors hindering or amplifying the effectiveness of consensus messages, it is also essential to investigate the interplay of those additional moderating factors in future research.

Taken together, our results add to the already existing literature on the gateway belief model showing that integrating new information into prior knowledge is conditional on confidence in said knowledge above and beyond political ideology and prior knowledge (Cook & Lewandowsky, 2016; van der Linden et al., 2019).

High confidence in post-treatment PSC. Our second analysis showed that higher confidence in post-treatment PSC is related to a higher adjustment of the initial PSC toward the consensus. There are several possible explanations for this finding. One might be that those participants had higher trust in the accuracy of the consensus message or generally believed the consensus message more, which would not only have an effect on updating the PSC (Jaccard, 1981) but might also lead to higher post-treatment confidence (Slater & Rouner, 1992). Slater and Rouner (1992), for example found in their experiment that a higher discrepancy between initial beliefs and the content of the new information leads to higher confidence in the updated belief. To explain this finding, the authors suggested that integrating new information into an established set of beliefs might lead to more complexity and, thus, an increase in confidence. Put differently, by expanding their belief set, participants might feel more confident in those beliefs as they now encompass more information. Another explanation might be that participants, who could remember the consensus message better did not only adjust their PSC more but were also more confident that their estimate was correct. As has been shown in previous research, ease of information access from memory is related to, e.g., higher frequency judgments of the information (Tversky & Kahnemann, 1973), can influence the believability of information (Ozubko & Fugelsang, 2011), and might lead to higher confidence estimates when making a judgment. However, regarding the relationship between ease of accessibility of information

6 Also see Brewer & McKnight (2017) who identified interest as important moderator in the gateway belief model.

from memory and confidence ratings one needs to exercise caution. Even though there is some research investigating whether there is a relationship between information accessibility and confidence ratings, evidence supporting such a relationship is inconclusive at best (Morris, 1990; Treadwell & Nelson, 1996).

Updating Climate Change Attitudes: Confidence in Perceived Scientific Consensus as Moderator

Results showed that the relationship between post-treatment PSC and updating the belief in the anthropogenic cause of climate change was stronger the more confident participants were in their post-treatment PSC. As has been argued by Fischer and Said (2021) one explanation could be that higher confidence in one's knowledge, in our case peoples' estimate of the PSC, might be related to a higher likelihood to elicit similar beliefs. This finding is of high relevance since increasing climate change attitudes - and not PSC - should be a main goal of climate change communication. At the same time, these attitudes are more difficult to change than PSC and, regarding consensus messaging, yield smaller effect sizes due to the mediated nature of the gateway belief model. Thus, identifying factors which might enhance the consensus message's effectiveness on these latter attitudes is highly relevant, and confidence in PSC seems to be a promising candidate.

Our study did find this relationship only for one climate change attitude: belief in human causation of climate change. This result is not surprising as there was only a direct effect of PSC on the aforenamed attitude (human causation of climate change). Even though there might be several reasons why the other climate change attitudes were not affected by the consensus message, not having enough statistical power due to our sample size is the most likely. Thus, an important next step would be to replicate the full gateway belief model to investigate whether confidence in PSC does have an effect on all of the climate change attitudes.

Conclusion. Scientists agree that human-caused climate change poses an unprecedented threat to our well-being and existence. Thus, counteracting climate change must be of utmost importance to all of us. Nevertheless, some still do not believe climate change to be human-caused or even question its general existence. Therefore, efficient strategies to increase the public's awareness of climate change are essential to tackle this challenge. The aim of our paper was to understand how

metacognition (i.e. confidence) contributes to the strategy of consensus messaging. Our results show that metacognition plays a role in two important ways: first, by putting a constraint on the effectiveness of consensus messaging concerning peoples' willingness to integrate new information, and second, by enhancing the influence of the PSC on the subsequent climate change attitudes, that is belief in human-causation. Thus, in future research, it might not only be essential to target peoples' perceived scientific consensus but also develop methods that take peoples' confidence in the accuracy of their estimate into account. More specifically, one could integrate or adapt strategies that specifically target confidence, for example by using adaptive training strategies to increase metacognitive abilities (Carpenter et al., 2019).

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Formal analysis: NS, LF
Methodology: NS, LF
Project administration: NS
Visualization: LF
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Writing – review & editing: NS, LF, MH

Appendix

Table A1

Items Used to Measure the Dependent Variables

Variable	Item	Response Scale
Belief in global warming	How strongly do you believe that global warming is or is not happening?	Seven-point scale: 1 = *I strongly believe that global warming IS NOT happening*, 4 =*I am unsure whether or not global warming is happening*, 7 = *I strongly believe global warming IS happening*
Belief in human causation	Assuming global warming is happening: How much of it do you believe is caused by human activities, natural changes in the environment, or a combination of both?	Seven-point scale: 1 = *I believe that global warming is caused mostly by natural changes in the environment*, 4 = *I believe that global warming is caused equally by natural changes and human activities*, 7 = *I believe that global warming is caused mostly by human activities*
Worry about global warming	How worried are you about global warming?	Seven-point scale: 1 = *I am not at all worried about global warming*, 4 = *neutral*, 7 = *I am very worried about global warming*
Support for action on global warming	Do you think people should be doing more or less to reduce global warming?	Seven-point scale: 1 = *Much less*, 4 = *Same amount*, 7 = *Much more*
Perceived scientific consensus	To the best of your knowledge, what percentage of climate scientists have concluded that human-caused global warming is happening?	Continuous scale from 0% - 100%
Confidence in perceived scientific consensus	How certain are you about your estimation?	Continuous scale from 50% - 100%: 50%: *I was guessing*, 100%: *I know the answer*

Note. Items to measure climate change attitudes and perceived scientific consensus were adopted from van der Linden et al. (2019).

Table A2

Climate Change Knowledge Test

Statement	Correct Response
The global average temperature in the air has increased approx. 3.1℃ (5.6 F) in the past 100 years.	False
An increasing amount of greenhouse gases increases the amount of UV radiation and therefore bears a larger risk of skin cancer.	False
Climate change is mainly caused by a natural variation in solar radiation and volcanic eruption.	False
It is not possible to establish if the past 100 years had different temperatures compared to the previous 1,000 years.	False
The global average temperature in the air has been stable over the past 100 years.	False
Climate change is mainly caused by the ozone hole.	False
The ice mass of the Artic is expected to increase in the next 100 years.	False
In most areas north of 45°N latitude, precipitation levels have increased over the past 100 years.	True
Carbon dioxide concentration in the atmosphere has increased by more than 30% over the past 250 years.	True
The increase of greenhouse gases in the atmosphere is mainly caused by human activity.	True
Carbon dioxide is responsible for approximately 80% of the increase in greenhouse gas emissions.	True
The blanket of snow in the Northern Hemisphere has decreased more than 10% since the 1960s.	True
A cause of the raising sea level is the melting of glaciers and snow.	True

Note. Items were adopted from Sundblad et al. (2009)

Table A3

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
Age	47.24	15.29								
Ideology	2.96	1.07	-.21** [-.28, -.15]							
Belief	5.60	1.72	-.11** [-.17, -.05]	.50** [.45, .54]						
Human Causation	5.07	1.78	-.18** [-.25, -.12]	.48** [.43, .53]	.75** [.71, .77]					
Worry	5.01	1.93	-.13** [-.19, -.06]	.53** [.48, .57]	.80** [.78, .82]	.74** [.71, .77]				
Support	5.61	1.60	-.10** [-.17, -.04]	.47** [.42, .52]	.78** [.76, .81]	.72** [.69, .75]	.80** [.77, .82]			
Confidence	3.06	1.39	-.03 [-.09, .04]	.21** [.14, .27]	.28** [.22, .34]	.26** [.20, .32]	.29** [.23, .35]	.27** [.21, .33]		
Meta-d‘	0.30	0.77	-.06 [-.12, .01]	.16** [.09, .22]	.19** [.12, .25]	.19** [.12, .25]	.21** [.14, .27]	.19** [.13, .26]	.34** [.28, .39]	
d_prime	0.86	0.92	-.01 [-.07, .06]	.32** [.26, .38]	.60** [.56, .64]	.53** [.48, .58]	.55** [.51, .60]	.56** [.51, .60]	.28** [.21, .34]	.15** [.08, .21]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table A4.1

Mediation model parameters for model with one direct effect of condition on PSC (direct effects)

Model path relationships	Coefficient	SE	99% CI	z	p
PSC ~ Condition	0.77	0.06	[0.61, 0.94]	12.47	< .001***
Support of Action ~ PSC	0.07	0.04	[-0.03, 0.18]	1.69	0.091
Belief in CC ~ PSC	0.03	0.04	[-0.07, 0.13]	0.80	0.426
Worry about CC ~ PSC	0.01	0.04	[-0.08, 0.11]	0.38	0.705
human causation of CC ~ PSC	0.11	0.05	[-0.03, 0.25]	2.10	.036*
Worry about CC ~ Belief in CC	0.11	0.06	[-0.03, 0.28]	1.81	.070
Worry about CC ~ human causation of CC	0.17	0.06	[0.02, 0.32]	3.01	.003**
Support of Action ~ Belief in CC	0.14	0.06	[-0.02, 0.32]	2.21	.027*
Support of Action ~ Worry about CC	0.12	0.07	[-0.05, 0.31]	1.67	.095
Support of Action ~ human causation of CC	0.04	0.06	[-0.14, 0.20]	0.55	0.585

Note. CC = Climate Change; PSC = Perceived Scientific Consensus;* indicates p < .05. ** indicates p < .01. *** indicates p < .001.

Table A4.2

Mediation model parameters for model with one direct effect of condition on PSC (indirect effects and total effect)

Model path relationships	Coefficient	SE	99% CI	z	p
PSC → Belief in CC → Worry about CC	3.47e-03	5.36e-03	[-0.01, 0.02]	0.65	0.517
PSC → human causation of CC → Worry about CC	0.02	0.01	[0.00, 0.05]	1.74	0.082
PSC → Belief in CC → Support of Action	4.34e-03	6.49e-03	[-0.01, 0.03]	0.67	0.503
PSC → human causation of CC → Support of Action	3.07e-03	8.06e-03	[-0.02, 0.03]	0.38	0.704
PSC → Worry about CC → Support of Action	1.72e-03	5.47e-03	[-0.01, 0.02]	0.31	0.754
Total effect	0.87	0.07	[0.68, 1.05]	12.03	< .001***

Note. CC = Climate Change; PSC = Perceived Scientific Consensus;* indicates p < .05. ** indicates p < .01. *** indicates p < .001.

Table A5.1

Mediation model parameters for model with one direct effect of condition on PSC including age, gender, education, and ideology as covariates (direct effects)

Model path relationships	Coefficient	SE	99% CI	z	p
PSC ~ Condition	0.77	0.06	[0.61, 0.92]	13.01	< .001 ***
PSC ~ Age	0.02	0.03	[-0.05, 0.10]	0.79	0.430
PSC ~ Ideology	-0.18	0.03	[-0.26, -0.10]	-5.82	< .001***
PSC ~ Education	-0.03	0.03	[-0.10, 0.04]	-1.00	0.317
PSC ~ Gender	0.03	0.06	[-0.13, 0.19]	0.51	0.608
Support of Action ~ PSC	0.07	0.04	[-0.03, 0.18]	1.70	0.089
Belief in CC ~ PSC	0.03	0.04	[-0.07, 0.13]	0.82	0.415
Worry about CC ~ PSC	0.01	0.04	[-0.08, 0.11]	0.38	0.706
human causation of CC ~ PSC	0.11	0.05	[-0.02, 0.25]	2.09	.036*
Worry about CC ~ Belief in CC	0.11	0.06	[-0.04, 0.27]	1.79	.074
Worry about CC ~ human causation of CC	0.17	0.06	[0.02, 0.32]	3.04	.002 **
Support of Action ~ Belief in CC	0.14	0.06	[-0.01, 0.31]	2.26	.024*
Support of Action ~ Worry about CC	0.12	0.07	[-0.05, 0.32]	1.67	.094
Support of Action ~ human causation of CC	0.04	0.06	[-0.14, 0.19]	0.55	0.585

Note. CC = Climate Change; PSC = Perceived Scientific Consensus;* indicates p < .05. ** indicates p < .01. *** indicates p < .001.

Table A5.2

Mediation model parameters for model with one direct effect of condition on PSC including age, gender, education, and ideology as covariates (indirect effects and total effect)

Model path relationships	Coefficient	SE	99% CI	z	p
PSC → Belief in CC → Worry about CC	3.47e-03	5.28e-03	[-0.01, 0.02]	0.66	0.511
PSC → human causation of CC → Worry about CC	0.02	0.01	[0.00, 0.05]	1.76	0.079
PSC → Belief in CC → Support of Action	4.34e-03	6.34e-03	[-0.01, 0.03]	0.69	0.493
PSC → human causation of CC → Support of Action	3.07e-03	8.03e-03	[-0.03, 0.02]	0.38	0.703
PSC → Worry about CC → Support of Action	1.72e-03	5.49e-03	[-0.01, 0.02]	0.31	0.755
Total effect	0.87	0.07	[0.68, 1.04]	12.27	< .001***

Note. CC = Climate Change; PSC = Perceived Scientific Consensus;* indicates p < .05. ** indicates p < .01. *** indicates p < .001.

A6 Metacognitive sensitivity as Moderator in the Gateway Belief Model

As pre-registered, we wanted to investigate the role of metacognitive sensitivity as a moderator in the gateway belief model. We assumed that higher metacognitive sensitivity is related to a higher adjustment of the PSC towards the consensus in the experimental condition.

Metacognitive sensitivity denotes the extent to which confidence ratings are predictive of task performance and therefore indicates how well a person can evaluate his or her cognitive processes (Fleming & Lau, 2014; Maniscalco & Lau, 2012). Metacognitive sensitivity plays a role in various cognitive domains like perception (Rollwage et al., 2018), memory (McCurdy et al., 2013), and knowledge (Fischer et al., 2019).

Concerning the question of whether metacognitive sensitivity is related to (updating) beliefs and attitudes, a recent study found low levels of metacognitive sensitivity measured in a perceptual task to be predictive of the holding of more radical political beliefs (Rollwage et al., 2018). Furthermore, participants with low metacognitive sensitivity showed less integration of post-decisional evidence, as they were less willing to adapt their confidence ratings to new evidence. In the described study, metacognitive sensitivity and evidence integration were measured in a low-level perceptual task without any content meaning. However, since these measures were predictive of the participants' political beliefs, it appears likely that metacognitive sensitivity moderates the integration of evidence in different contexts. Following this interpretation, the relationship between political beliefs and metacognitive sensitivity should arise from the resistance of people with low metacognitive sensitivity to update their beliefs – or the knowledge on which these beliefs are built – to new evidence. We, therefore, assume that metacognitive sensitivity should also predict evidence integration in the consensus messaging process. Referring to the gateway belief model, we expect metacognitive sensitivity to moderate the debiasing process, i.e., the integration of the consensus message into the estimation of scientific consensus. Other than Rollwage et al. (2018), we do not assess metacognitive sensitivity in a perceptual task but in a knowledge test about climate change (cf. Fischer et al., 2019). This measure has the advantage of being closer to the domain of evidence integration we investigate. Correlational findings further suggest metacognitive efficiency (i.e.,

metacognitive sensitivity given a fixed value of task performance) to be a domain-general characteristic (Mazancieux et al., 2020; McCurdy et al., 2013; but see Fitzgerald et al., 2017), which is why we assume that the findings of Rollwage et al. (2018) should be transferable to other domains of metacognitive sensitivity.

Measures

Climate Change Knowledge and Confidence in Climate Change Knowledge. To assess climate change knowledge, participants had to answer a knowledge test consisting of seven false and six true statements about climate change (adopted from Sundblad et al., 2009). Participants had to indicate whether the statements about climate change were true or false. Furthermore, confidence in climate change knowledge was assessed for each statement ("how confident are you, that your answer is correct?") on a 6-point scale ranging from "50% I guessed" to "100% I am sure". The statement: "The global change in temperature in the last 100 years is the largest during the past 1,000 years." was displayed twice serving as an attention check. Participants who gave two different answers to the question on whether this statement is correct were excluded. Responses to the statement were not included in the climate change knowledge score.[7]

Metacognitive sensitivity. To calculate a bias free measure of the confidence-accuracy relationship, that is, *metacognitive sensitivity* meta-d', we applied a Bayesian estimation method (Fleming, 2017). *Metacognitive sensitivity* is a measure that reflects how well participants' confidence in their climate change knowledge aligns with their actual climate change knowledge.

Task sensitivity. To calculate a bias free measure for participants' climate change knowledge, *task sensitivity d'* was computed as the *Z*(hit rate) - *Z*(false-alarm rate).[8]

Results

7 Note that this deviates from the pre-registration in which the exclusion criteria was „psychology students". However, as it is very unlikely that students are familiar with the concept of the GBM we decided to exclude participants based on the attention check.

8 Note that *Z* refers to the inverse cumulative density function of the normal distribution.

Mean climate change knowledge was *M = 0.64* (*SD = 0.16*) and mean metacognitive sensitivity was *M = 0.29 (SD = 0.77)*. Furthermore, participants' metacognitive efficiency was calculated using the hierarchical version of the Bayesian model (Fleming, 2017). Metacognitive efficiency reflects peoples insight into the accuracy of their own climate change knowledge while controlling for their performance in the climate change knowledge task. The mean value of metacognitive efficiency was *M* = 0.61 (*SD* = 0.27), which is similar to estimations of German citizens' metacognitive efficiency (M = 0.47) regarding climate change knowledge (Fischer et al., 2019).

We calculated a simple regression analysis. Dependent variable was the change score of the perceived scientific consensus. As independent variables the interaction between experimental condition and meta-*d'* was included. Furthermore, we controlled for climate change knowledge (in our case task-sensitivity *d'*), political ideology, gender, age, education, and pre-treatment PSC. Results showed that there was a significant interaction effect between experimental condition and pre-treatment PSC, $F(23, 874) = 22.19$, $p < .001$, $R^2 = .37$, $R^2_{Adjusted} = .35$, $b_{PSC} = -0.47$, $t_{PSC}(874) = -7.49$, $p_{PSC} < .001$, as well as the interaction between ideology and experimental condition, $b_{Ideology} = -0.14$, $t_{Ideology}(874) = -2.30$, $p_{Ideology} = .021$. The interaction effect between meta-*d'* and condition as well as the interaction effect between *d'* and condition were not significant, $b_{meta\text{-}d'xPSC} = 0.004$, $t_{meta\text{-}d'xPSC}(874) = .071$, $p_{meta\text{-}d'xPSC} = .943$, $b_{d'xPSC} = .029$, $t_{dxPSC}(874) = .463$, $p_{d'xPSC} = 0.64$. Exploratory, we ran the same analyses again with the full sample *N = 1,094*. Even though we did not find an interaction effect, results revealed a marginally significant main effect of metacognitive sensitivity on the simple change score of PSC: $F(23, 1026) = 23.44$, $p < .001$, $R^2 = .33$, $R^2_{Adjusted} = .32$, $b_{meta\text{-}d'} = .06$, $t_{meta\text{-}d'}(1026) = 1.74$, $p_{meta\text{-}d'} = .08$. And a significant main effect of metacognitive sensitivity on the relative change score of PSC: $F(23, 1026) = 16.76$, $p < .001$, $R^2 = .27$, $R^2_{Adjusted} = .26$, $b_{meta\text{-}d'} = .08$, $t_{meta\text{-}d'}(1026) = 1.97$, $p_{meta\text{-}d'} = .049$.

That is, higher insight into the accuracy into one's own climate change knowledge seems to be associated with adjusting the PSC more towards the scientific consensus.

Discussion

We assumed that metacognitive sensitivity moderates the extent to which the consensus message was integrated into the participants' knowledge. However, our data did not support this assumption. One reason could be that effects might be very small and thus, an interaction could not be detected with our sample size. Furthermore, we estimated metacognitive sensitivity for each participant based on their answers to a climate change knowledge test consisting of only thirteen items. This very low item number might not suffice to adequately model metacognitive sensitivity, which could be an explanation why we did not find the predicted interaction. A third reason for not finding an interaction effect could be that the process of evidence integration we investigated, i.e., the integration of the consensus message into the participants' prior estimate of scientific consensus, was too simple to depict the complex relationship between metacognitive sensitivity and evidence integration. Knowledge about the scientific consensus only constitutes one piece of knowledge a person holds, and the confidence in this specific information does not necessarily reflect this person's metacognitive sensitivity. Therefore, the absence of an effect of metacognitive sensitivity on the integration of one piece of evidence does not preclude possible effects when regarding the sampling of more complex evidence or repeated evidence sampling. Put more clearly, low metacognitive sensitivity does not imply that the respective person assigns undue confidence to every false knowledge or belief they hold. However, when looking at this person's complete knowledge, it could be more likely that some false convictions outlive the confrontation with competing evidence due to inflated confidence. Since key personal beliefs do not only depend on single pieces of knowledge but on the collection of all these pieces, such long-term effects of metacognitive sensitivity could still have considerable impacts on belief formation.

While we did not find an interaction effect when participants who failed the attention check were excluded from the analysis inclusion of all participants revealed a main effect of metacognitive sensitivity on the updating process. Even though evidence only hints towards this relationship and needs to be interpreted with caution as non-attentive participants might have influenced the results,

this is still interesting as it shows that higher insight in ones' one knowledge seems to impact how much participants updated their PSC toward the consensus independently from the condition. One reason could be that participants who did not receive the message but nonetheless updated their PSC towards the consensus might have used their metacognitive abilities to correct their estimate when asked the second time. As, especially with respect of climate change, people are usually confronted with a noisy information environment, it is possible that, when given the chance to make the estimate again, participant with higher metacognitive insight, were able to use their insight, to adjust their estimate of the PSC.

The fact that we did not find metacognitive sensitivity to moderate the debiasing process does not imply that metacognitive sensitivity cannot have effects on evidence integration in general. As the existing literature on this field of study is very limited, future research should proceed to investigate the relationship between metacognition and personal beliefs. In particular, the possibility of metacognitive sensitivity being associated with less evidence integration should be investigated in settings of repeated evidence sampling or with stimulus material that is more complex and not limited to very specific pieces of knowledge.

A7 Updating PSC: The Role of Confidence in Perceived Scientific Consensus. Replication with a representative German sample.

We re-analyzed the data from Authors, 2022 (*N = 1110*, representative sample of the German population; https://osf.io/r26m7/). Again we did find a negative interaction between confidence in pre-treatment PSC and experimental condition: $F_{(1)}(13, 1080) = 30.48$, $p_{(1)} < .001$, $R_{(1)}^2 = .27$, $R_{(1)}^2{}_{Adjusted} = .26$, $b_{(1)PSC} = -0.14$, $t_{(1)PSC}(1080) = -2.47$s, $p_{(1)PSC} = .013$, and a positive interaction between confidence in post-treatment PSC and experimental condition $F_{(2)}(13, 1080) = 56.16$, $p_{(2)} < .001$, $R_{(2)}^2 = .40$, $R_{(2)}^2{}_{Adjusted} = .40$, $b_{(2)PSC} = 0.60$, $t_{(2)PSC}(1080) = 10.90$, $p_{(2)PSC} < .001$. This again did also hold when using the relative change score: $F_{(1)}(13, 1044) = 33.68$, $p_{(1)} < .001$, $R_{(1)}^2 = .30$, $R_{(1)}^2{}_{Adjusted} = .29$, $b_{(1)PSC} = -.15$, $t_{(1)PSC}(1044) = -2.69$, $p_{(1)PSC} = .007$. $F_{(2)}(13, 1044) = 54.19$, $p_{(2)} < .001$, $R_{(2)}^2 = .40$, $R_{(2)}^2{}_{Adjusted} = .40$, $b_{(2)PSC} = 0.57$, $t_{(2)PSC}(1044) = 10.07$, $p_{(2)PSC} < .001$.

Table A8

Regression results using the „belief“change score as the criterion, controlling for pre-treatment „belief“ and experimental condition

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit	Difference
(Intercept)	0.28	[-0.34, 0.89]				
Condition	-0.12	[-0.25, 0.01]	.00	[-.00, .01]		
PSC2	0.10	[-0.39, 0.58]	.00	[-.00, .00]		
Geschlecht	-0.00	[-0.13, 0.13]	.00	[-.00, .00]		
Belief1	-0.35**	[-0.43, -0.27]	.08	[.04, .11]		
Age	-0.11**	[-0.18, -0.04]	.01	[-.00, .02]		
Ideology	0.13**	[0.05, 0.20]	.01	[-.00, .02]		
Education2	-0.30	[-0.91, 0.32]	.00	[-.00, .00]		
Education3	-0.20	[-0.81, 0.41]	.00	[-.00, .00]		
Education4	-0.23	[-0.85, 0.40]	.00	[-.00, .00]		
Education5	-0.02	[-0.83, 0.79]	.00	[-.00, .00]		
Education6	-0.02	[-0.67, 0.63]	.00	[-.00, .00]		
Condition:PSC2	0.05	[-0.08, 0.18]	.00	[-.00, .00]		
PSC2:Gender	-0.08	[-0.21, 0.05]	.00	[-.00, .01]		
PSC2:Belief1	0.04	[-0.03, 0.11]	.00	[-.00, .01]		
PSC2:Age	-0.04	[-0.11, 0.03]	.00	[-.00, .01]		
PSC2:Ideology	-0.12**	[-0.20, -0.04]	.01	[-.00, .02]		
PSC2:Education2	0.06	[-0.41, 0.52]	.00	[-.00, .00]		
PSC2:Education3	0.05	[-0.42, 0.52]	.00	[-.00, .00]		
PSC2:Education4	0.20	[-0.29, 0.69]	.00	[-.00, .00]		
PSC2:Education5	-0.06	[-0.87, 0.75]	.00	[-.00, .00]		
PSC2:Education6	0.14	[-0.35, 0.64]	.00	[-.00, .00]		
					R^2 = .119** 95% CI[.06,.14]	
(Intercept)	0.25	[-0.36, 0.87]				
PSC2	0.14	[-0.35, 0.64]	.00	[-.00, .00]		
Confidence PSC2	-0.01	[-0.09, 0.07]	.00	[-.00, .00]		
Condition	-0.13	[-0.26, 0.01]	.00	[-.00, .01]		
Gender	-0.01	[-0.14, 0.12]	.00	[-.00, .00]		
Belief1	-0.35**	[-0.43, -0.27]	.08	[.04, .11]		
Age	-0.11**	[-0.18, -0.05]	.01	[-.00, .02]		
Ideology	0.13**	[0.06, 0.20]	.01	[-.00, .02]		
Education2	-0.28	[-0.90, 0.33]	.00	[-.00, .00]		
Education3	-0.19	[-0.80, 0.43]	.00	[-.00, .00]		
Education4	-0.21	[-0.84, 0.42]	.00	[-.00, .00]		
Education5	-0.01	[-0.82, 0.80]	.00	[-.00, .00]		
Education6	-0.01	[-0.66, 0.64]	.00	[-.00, .00]		
PSC2:Confidence in PSC2	0.03	[-0.04, 0.10]	.00	[-.00, .00]		
PSC2:Condition	0.05	[-0.09, 0.18]	.00	[-.00, .00]		
PSC2:Gender	-0.07	[-0.21, 0.06]	.00	[-.00, .01]		
PSC2:Belief1	0.05	[-0.02, 0.12]	.00	[-.00, .01]		
PSC2:Age	-0.04	[-0.11, 0.03]	.00	[-.00, .01]		
PSC2:Ideology	-0.12**	[-0.20, -0.04]	.01	[-.00, .02]		
PSC2:Education2	0.03	[-0.44, 0.50]	.00	[-.00, .00]		

PSC2:Education3	0.01	[-0.47, 0.49]	.00	[-.00, .00]		
PSC2:Education4	0.17	[-0.33, 0.66]	.00	[-.00, .00]		
PSC2:Education5	-0.10	[-0.91, 0.72]	.00	[-.00, .00]		
PSC2:Education6	0.11	[-0.39, 0.61]	.00	[-.00, .00]		
					R^2 = .119**	ΔR^2 = .001
					95% CI[.06,.14]	95% CI[-.00, .00]

Note. PSC2 = post-treatment perceived scientific consensus, Confidence PSC3 = confidence in post-treatment perceived scientific consensus, Belief1 = pre-treatment belief in climate change. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * indicates $p < .05$, ** indicates $p < .01$.

Table A9

Regression results using the „human causation" change score as the criterion, controlling for pre-treatment „human causation" and experimental condition

		b		*sr²*		
Predictor	*b*	95% CI [LL, UL]	*sr²*	95% CI [LL, UL]	Fit	Difference
(Intercept)	0.29	[-0.31, 0.88]				
Condition	0.15*	[0.02, 0.28]	.00	[-.00, .01]		
PSC2	-0.49*	[-0.96, -0.02]	.00	[-.00, .01]		
Geschlecht	-0.09	[-0.22, 0.03]	.00	[-.00, .01]		
HC1	-0.44**	[-0.52, -0.36]	.11	[.07, .15]		
Age	-0.08*	[-0.15, -0.02]	.01	[-.00, .01]		
Ideology	0.16**	[0.08, 0.23]	.02	[.00, .03]		
Education2	-0.40	[-0.99, 0.20]	.00	[-.00, .01]		
Education3	-0.35	[-0.94, 0.25]	.00	[-.00, .01]		
Education4	-0.27	[-0.87, 0.34]	.00	[-.00, .00]		
Education5	-0.27	[-1.05, 0.51]	.00	[-.00, .00]		
Education6	-0.13	[-0.75, 0.50]	.00	[-.00, .00]		
Condition:PSC2	-0.07	[-0.20, 0.06]	.00	[-.00, .00]		
PSC2:Gender	-0.10	[-0.23, 0.03]	.00	[-.00, .01]		
PSC2:HC1	0.03	[-0.04, 0.09]	.00	[-.00, .00]		
PSC2:Age	-0.03	[-0.10, 0.04]	.00	[-.00, .00]		
PSC2:Ideology	-0.00	[-0.07, 0.07]	.00	[-.00, .00]		
PSC2:Education2	0.72**	[0.27, 1.17]	.01	[-.00, .02]		
PSC2:Education3	0.82**	[0.37, 1.27]	.01	[-.00, .03]		
PSC2:Education4	0.90**	[0.43, 1.37]	.01	[-.00, .03]		
PSC2:Education5	0.63	[-0.15, 1.41]	.00	[-.00, .01]		
PSC2:Education6	0.91**	[0.44, 1.39]	.01	[-.00, .03]		
					R^2 = .175**	
					95% CI[.11,.20]	
(Intercept)	0.26	[-0.34, 0.85]				
PSC2	-0.40	[-0.87, 0.08]	.00	[-.00, .01]		
Confidence PSC2	0.03	[-0.05, 0.11]	.00	[-.00, .00]		
Condition	0.12	[-0.01, 0.25]	.00	[-.00, .01]		

Gender	-0.09	[-0.22, 0.03]	.00	[-.00, .01]		
HC1	-0.45**	[-0.53, -0.37]	.12	[.08, .15]		
Age	-0.08*	[-0.15, -0.02]	.01	[-.00, .02]		
Ideology	0.16**	[0.08, 0.23]	.02	[.00, .03]		
Education2	-0.38	[-0.98, 0.21]	.00	[-.00, .01]		
Education3	-0.33	[-0.93, 0.26]	.00	[-.00, .01]		
Education4	-0.25	[-0.86, 0.35]	.00	[-.00, .00]		
Education5	-0.27	[-1.05, 0.51]	.00	[-.00, .00]		
Education6	-0.12	[-0.74, 0.51]	.00	[-.00, .00]		
PSC2:Confidence in PSC2	0.08*	[0.02, 0.15]	.01	[-.00, .01]		
PSC2:Condition	-0.09	[-0.23, 0.04]	.00	[-.00, .01]		
PSC2:Gender	-0.07	[-0.20, 0.06]	.00	[-.00, .01]		
PSC2:HC1	0.02	[-0.05, 0.09]	.00	[-.00, .00]		
PSC2:Age	-0.02	[-0.09, 0.05]	.00	[-.00, .00]		
PSC2:Ideology	-0.01	[-0.08, 0.06]	.00	[-.00, .00]		
PSC2:Education2	0.64**	[0.19, 1.09]	.01	[-.00, .02]		
PSC2:Education3	0.73**	[0.28, 1.19]	.01	[-.00, .02]		
PSC2:Education4	0.82**	[0.34, 1.29]	.01	[-.00, .02]		
PSC2:Education5	0.51	[-0.28, 1.29]	.00	[-.00, .01]		
PSC2:Education6	0.82**	[0.34, 1.30]	.01	[-.00, .02]		
					R^2 = .180**	ΔR^2 = .006*
					95% CI[.12,.20]	95% CI[-.00, .01]

Note. PSC2 = post-treatment perceived scientific consensus, Confidence PSC3 = confidence in post-treatment perceived scientific consensus, HC1 = pre-treatment belief in human causation of climate change. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * indicates $p < .05$, ** indicates $p < .01$.

Table A10

Regression results using the„worry about climate change“ change score as the criterion, controlling for pre-treatment „worry about climate change“ and experimental condition

		b		*sr²*		
Predictor	*b*	95% CI [LL, UL]	sr^2	95% CI [LL, UL]	Fit	Difference
(Intercept)	-0.03	[-0.65, 0.59]				
Condition	-0.01	[-0.14, 0.13]	.00	[-.00, .00]		
PSC2	0.16	[-0.32, 0.64]	.00	[-.00, .00]		
Geschlecht	0.04	[-0.08, 0.17]	.00	[-.00, .00]		
Worry1	-0.34**	[-0.42, -0.26]	.07	[.04, .10]		
Age	-0.11**	[-0.18, -0.04]	.01	[-.00, .02]		
Ideology	0.17**	[0.10, 0.25]	.02	[.00, .04]		
Education2	-0.06	[-0.67, 0.56]	.00	[-.00, .00]		
Education3	0.04	[-0.57, 0.66]	.00	[-.00, .00]		
Education4	-0.05	[-0.68, 0.58]	.00	[-.00, .00]		
Education5	0.20	[-0.61, 1.01]	.00	[-.00, .00]		
Education6	0.16	[-0.49, 0.80]	.00	[-.00, .00]		

Condition:PSC2	-0.06	[-0.19, 0.08]	.00	[-.00, .00]		
PSC2:Gender	-0.19**	[-0.32, -0.06]	.01	[-.00, .02]		
PSC2:Worry1	0.06	[-0.02, 0.14]	.00	[-.00, .01]		
PSC2:Age	0.00	[-0.07, 0.08]	.00	[-.00, .00]		
PSC2:Ideology	-0.08*	[-0.16, -0.00]	.00	[-.00, .01]		
PSC2:Education2	0.13	[-0.34, 0.59]	.00	[-.00, .00]		
PSC2:Education3	0.11	[-0.36, 0.58]	.00	[-.00, .00]		
PSC2:Education4	0.36	[-0.13, 0.85]	.00	[-.00, .01]		
PSC2:Education5	-0.07	[-0.88, 0.74]	.00	[-.00, .00]		
PSC2:Education6	0.08	[-0.41, 0.58]	.00	[-.00, .00]		
					R^2 = .114** 95% CI[.06,.13]	
(Intercept)	-0.03	[-0.65, 0.58]				
PSC2	0.17	[-0.32, 0.66]	.00	[-.00, .00]		
Confidence PSC2	0.02	[-0.06, 0.10]	.00	[-.00, .00]		
Condition	-0.02	[-0.16, 0.12]	.00	[-.00, .00]		
Gender	0.05	[-0.08, 0.17]	.00	[-.00, .00]		
Worry1	-0.34**	[-0.42, -0.26]	.07	[.04, .10]		
Age	-0.11**	[-0.18, -0.04]	.01	[-.00, .02]		
Ideology	0.17**	[0.10, 0.25]	.02	[.00, .04]		
Education2	-0.06	[-0.67, 0.56]	.00	[-.00, .00]		
Education3	0.04	[-0.58, 0.66]	.00	[-.00, .00]		
Education4	-0.05	[-0.68, 0.58]	.00	[-.00, .00]		
Education5	0.19	[-0.62, 1.00]	.00	[-.00, .00]		
Education6	0.15	[-0.50, 0.80]	.00	[-.00, .00]		
PSC2:Confidence in PSC2	0.02	[-0.05, 0.09]	.00	[-.00, .00]		
PSC2:Condition	-0.06	[-0.20, 0.07]	.00	[-.00, .00]		
PSC2:Gender	-0.19**	[-0.32, -0.05]	.01	[-.00, .02]		
PSC2:Worry1	0.06	[-0.02, 0.13]	.00	[-.00, .01]		
PSC2:Age	0.00	[-0.07, 0.08]	.00	[-.00, .00]		
PSC2:Ideology	-0.09*	[-0.17, -0.01]	.00	[-.00, .01]		
PSC2:Education2	0.11	[-0.36, 0.58]	.00	[-.00, .00]		
PSC2:Education3	0.09	[-0.39, 0.56]	.00	[-.00, .00]		
PSC2:Education4	0.34	[-0.15, 0.83]	.00	[-.00, .01]		
PSC2:Education5	-0.10	[-0.92, 0.71]	.00	[-.00, .00]		
PSC2:Education6	0.06	[-0.44, 0.56]	.00	[-.00, .00]		
					R^2 = .115** 95% CI[.06,.13]	ΔR^2 = .001 95% CI[-.00, .00]

Note. PSC2 = post-treatment perceived scientific consensus, Confidence PSC3 = confidence in post-treatment perceived scientific consensus, Worry1 = pre-treatment belief in worry about climate change. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * indicates $p < .05$, ** indicates $p < .01$.