

## Peer Review Information

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**Journal:** Nature Human Behaviour

**Manuscript Title:** The Einstein effect provides global evidence for scientific source credibility effects and the influence of religiosity

**Corresponding author name(s):** Suzanne Hoogeveen

### Reviewer Comments & Decisions:

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|------------------------------------------|
| <b>Decision Letter, initial version:</b> |
|------------------------------------------|

16th February 2021

Dear Ms Hoogeveen,

Thank you once again for your manuscript, entitled "The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity," and for your patience during the peer review process.

Your manuscript has now been evaluated by 2 reviewers, whose comments are included at the end of this letter. We are currently still awaiting the comments of a third reviewer. We will forward these comments, should we still receive them. Although the current reviewers find your work to be of interest, they also raise some important concerns. We are very interested in the possibility of publishing your study in Nature Human Behaviour, but would like to consider your response to these concerns in the form of a revised manuscript before we make a decision on publication.

Please address in full all reviewer comments. With respect to the pre-registration for this work, upon resubmission, we require that you provide us and reviewers with access to the original preregistration document - this can be done via a link specifically generated for peer review. On potential eventual publication, the current link to the partial preregistration (line 127 of your manuscript) can be provided, with a note explaining why the original preregistration cannot be shared at this time and that the copy supplied has been verified as an unaltered copy of the original preregistration document during peer review. Additionally, when submitting your revised manuscript, please alert us to any related manuscripts from your group that are under consideration or in press at other journals, or are being written up for submission to other journals, providing copies where available (see [www.nature.com/authors/policies/duplicate.html](http://www.nature.com/authors/policies/duplicate.html) for details).

Finally, your revised manuscript must comply fully with our editorial policies and formatting requirements. Failure to do so will result in your manuscript being returned to you, which will delay its

consideration. To assist you in this process, I have attached a checklist that lists all of our requirements. If you have any questions about any of our policies or formatting, please don't hesitate to contact me.

In sum, we invite you to revise your manuscript taking into account all reviewer and editor comments. We are committed to providing a fair and constructive peer-review process. Do not hesitate to contact us if there are specific requests from the reviewers that you believe are technically impossible or unlikely to yield a meaningful outcome.

We hope to receive your revised manuscript within four to eight weeks. We understand that the COVID-19 pandemic is causing significant disruption for many of our authors and reviewers. If you cannot send your revised manuscript within this time, please let us know - we will be happy to extend the submission date to enable you to complete your work on the revision.

With your revision, please:

- Include a "Response to the editors and reviewers" document detailing, point-by-point, how you addressed each editor and referee comment. If no action was taken to address a point, you must provide a compelling argument. This response will be used by the editors to evaluate your revision and sent back to the reviewers along with the revised manuscript.
- Highlight all changes made to your manuscript or provide us with a version that tracks changes.

Please use the link below to submit your revised manuscript and related files:

**[REDACTED]**

**Note:** This URL links to your confidential home page and associated information about manuscripts you may have submitted, or that you are reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage.

We look forward to seeing the revised manuscript and thank you for the opportunity to review your work. Please do not hesitate to contact me if you have any questions or would like to discuss these revisions further.

Sincerely,

Samantha Antusch  
Editor  
Nature Human Behaviour

Reviewer expertise:

Reviewer #1: multilevel Bayesian modelling with a background in social psychology

Reviewer #2: multilevel Bayesian modelling with expertise in source credibility effects / science

skepticism

Reviewer #3: source credibility effects / science skepticism and the influence of culture/religiosity on it

#### REVIEWER COMMENTS:

Reviewer #1:

Remarks to the Author:

First, I would like to apologize for taking so long with my review!

I have read the manuscript with great interest. I applaud the researchers for collecting such a large dataset. This must have been a major effort! I want to emphasize my appreciation of the openness about the analytic strategy and all the additional analyses performed.

I was very pleased to see the pre-registration. There are several footnotes and an appendix which refer to the pre-registration. Since it is not yet public, I cannot check any of the statements concerning the pre-registration and this part of the manuscript is therefore not peer-reviewed. I leave it up to the editor how to proceed.

The authors state that if the source is considered a trusted expert, people are willing to believe claims from that source without fully understanding them (lines 59-60). This statement is connected to the current COVID19 crises. Also, the authors define 'expert' as 'scientist', but I am not convinced this connection holds. What I observe in the current crisis is that people not necessarily trust the 'scientific' experts (in The Netherlands for example OMT members), but also 'semi'-experts (like Maurice de Hond) and clearly non-experts (e.g., Willem Engel from viruswaanzen). So, a 'trusted expert' is not necessarily a scientist, but it is a conceived expert in the eyes of the person you ask the question to. If the authors want to connect their study to the COVID19 case, I would like to ask them to dig deeper into the definition of 'expert' and how their data fits into the discussion of COVID19. Concerning the latter, who represents the spiritual guru in the case of COVID19?

On line 75 the authors link the credible authority to the likelihood model. Since the authors have used Bayesian statistics, did they consider to use the Bayesian paradigm instead? The general idea of the Bayesian framework is to combine prior knowledge with observed evidence. The prior can stem from many sources including experts. Expert elicitation is a huge field within the Bayesian community. The general challenge is to define who is an expert and if you have multiple experts how to weight their contribution to the prior. This can be done in several ways, including asking the expert to answer questions that measure their level of expertise. Based on these results experts can have a smaller or larger weight in the contribution to the prior via, so-called, power priors. This method is exactly what the authors describe and it would make sense to link their proposed 'Einstein effect' to existing literature on expert elicitation via Bayes theorem. Also, be aware that calling the proposed effect 'a likelihood model' does not really fit with the Bayesian statistics used for the analyses where the likelihood refers to the observed data.

On lines 174-176 the authors misinterpret the Bayesian results. If the BF between two models is

approximately one, than the support in the data for both models is (almost) identical. That should then be your conclusion. Simplicity is already part of the Bayes Factor. Hence, it means the data-generating model was not part of the models tested. You cannot select one of those models because it fits your conclusions better.

Some minor comments:

It was not clear to me why SES and level of education were used as covariates.

Are the correlations mentioned on lines 135-139 also obtained via Bayesian statistics? If so, please provide credibility intervals and specify which Bayesian software has been used.  
The M\_0 model should be an empty model without any predictors.

Information about the intraclass correlation is missing. How much of the variance is actually located at the country level?

Also, explained variances on both levels should be reported for each of the models.

Was a model with only the covariates tested? This model would be needed to check how much additional variance the predictors explain.

Information of establishing convergence is lacking, which metrics did the authors use to make sure the chains reached the target distribution for the all post-burn-in iterations?

Reviewer #2:

None

Reviewer #3:

Remarks to the Author:

I very much like this paper. To be honest, I can see little to prevent publication as it is. It is methodologically appropriate and the procedures are preregistered and transparent.

One caveat I would suggest the authors add is that although the experimental part of the design allows for attribution of causal effects, the fact that the sampling is essentially convenience wrt the countries involved, means that making country comparisons is something to be done with caution. It is good that there is a comparator analysis carried out on the additional survey data, but the country specific results are not really compared here in a visible way. Could they be?

The controls for confounding on the measured religiosity score are reasonable, although other correlates of religiosity, especially conservative or authoritarian worldviews cannot be ruled out as forming part of the reason for the observed source/religion interaction.

These are relatively minor points that could perhaps be considered for mention in the manuscript.



**Author Rebuttal to Initial comments**

Amsterdam, April 1, 2021

Dear Dr. Antusch,

We are happy to resubmit our manuscript “The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity” to *Nature Human Behaviour*.

We would like to thank the reviewers for the positive comments and the constructive feedback. Below we have provided a detailed point-by-point response (in bold) to the comments by the reviewers. The adjusted passages in the manuscript are indicated in blue and copied to this response letter. Mere textual edits are highlighted in the revision file.

We are happy to incorporate your suggestions and we are confident that these changes considerably improved the quality of the manuscript. We look forward to your decision.

Sincerely,

Suzanne Hoogeveen,  
also on behalf of the co-authors

**Comments by Reviewer 1**

[R 1.1] I have read the manuscript with great interest. I applaud the researchers for collecting such a large dataset. This must have been a major effort! I want to emphasize my appreciation of the openness about the analytic strategy and all the additional analyses performed.

**We thank the reviewer for their positive words and are happy that our efforts in data collection and transparency are well received.**

I was very pleased to see the pre-registration. There are several footnotes and an appendix which refer to the pre-registration. Since it is not yet public, I cannot check any of the statements concerning the pre-registration and this part of the manuscript is therefore not peer-reviewed. I leave it up to the editor how to proceed.

**We agree that the preregistration should be available for (peer-)review (and made public upon publication of the manuscript). We have now made the preregistration as well as the data openly available, since the project is no longer under embargo. The link to the pre-registration is now publicly available and included in the revised manuscript ([osf.io/xg8y5](https://osf.io/xg8y5)). We also note that the pre-registration document as linked to in the previous version of the manuscript <https://osf.io/faj2z/> is**

**the full and unmodified original pre-registration document for this study. The frozen registration component includes separate pre-registration documents for different research topics and questions that were bundled for data collection, but do not overlap with the current project (i.e., concerning different dependent variables).**

[R 1.2] The authors state that if the source is considered a trusted expert, people are willing to believe claims from that source without fully understanding them (lines 59-60). This statement is connected to the current COVID19 crises. Also, the authors define ‘expert’ as ‘scientist’, but I am not convinced this connection holds. What I observe in the current crisis is that people not necessarily trust the ‘scientific’ experts (in The Netherlands for example OMT members), but also ‘semi’-experts (like Maurice de Hond) and clearly non-experts (e.g., Willem Engel from viruswaanzen). So, a ‘trusted expert’ is not necessarily a scientist, but it is a conceived expert in the eyes of the person you ask the question to. If the authors want to connect their study to the COVID19 case, I would like to ask them to dig deeper into the definition of ‘expert’ and how their data fits into the discussion of COVID19. Concerning the latter, who represents the spiritual guru in the case of COVID19?

**First, we acknowledge that in the eyes of the lay public ‘expert’ and ‘scientist’ do not necessarily always refer to the same person. The perception of expertise and (relatedly) trustworthiness is somewhat subjective and depends on personal beliefs. This is exactly what our study shows: statements attributed to scientific authorities tend to be universally perceived as relatively more credible, whereas the credibility of statements attributed to spiritual authorities depends more on individuals’ religious worldviews. To address these points, we included the following revision on page 2/3, lines 70–74:**

In addition to competence, perceived benevolence is also taken into account in decisions about whom to trust<sup>1-4</sup>. In sum, who is considered an expert is strongly dependent on one’s prior worldview and beliefs about the source’s group membership: whereas some may consider scientists to be reliable experts, others may attribute expertise to shamans or gurus.

**Second, we chose to include the case of COVID-19 only as a timely example to introduce our general topic, but we do not further elaborate on trust and credibility of authorities related to COVID-19 specifically. That is, we believe that our findings bear a broader and more general relevance for understanding source credibility-effects, that go beyond the current situation. Many others have investigated the perception of experts in relation to COVID-19 specifically in great detail, see for instance<sup>5-11</sup>. While we prefer not to discuss COVID-19 at length in the manuscript, we are happy to quickly reflect here on the implications of these findings.**

**The pattern found in the studies referred to above is somewhat mixed, yet most data seem to suggest that trust in science/scientists has either remained the same or even increased during the pandemic. In the Netherlands for instance, the majority of the general public also still places more trust in the OMT and RIVM than Maurice de Hond or Willem Engel. This is for instance indirectly**

indicated by increased vaccination willingness over the last months (about 80% in NL). Moreover, the public still mostly relies on information regarding vaccination provided by vaccination centers (60.6%), the RIVM website (48.1%) and GPs (39.6%), to a stronger extent than that provided by the media (34.8%), trusted celebrities (2.5%) or social media (2%; see [www.rivm.nl/gedragsonderzoek/maatregelen-welbevinden/vaccinatiebereidheid](http://www.rivm.nl/gedragsonderzoek/maatregelen-welbevinden/vaccinatiebereidheid)). So while there are certainly individual differences in the perception of who is considered an expert, it seems that, on average, scientific expertise is still considered the most trustworthy source of information compared to other sources in relation to COVID-19 - and more generally as our study underlines.

[R 1.3] On line 75 the authors link the credible authority to the likelihood model. Since the authors have used Bayesian statistics, did they consider to use the Bayesian paradigm instead? The general idea of the Bayesian framework is to combine prior knowledge with observed evidence. The prior can stem from many sources including experts. Expert elicitation is a huge field within the Bayesian community. The general challenge is to define who is an expert and if you have multiple experts how to weight their contribution to the prior. This can be done in several ways, including asking the expert to answer questions that measure their level of expertise. Based on these results experts can have a smaller or larger weight in the contribution to the prior via, so-called, power priors. This method is exactly what the authors describe and it would make sense to link their proposed ‘Einstein effect’ to existing literature on expert elicitation via Bayes theorem. Also, be aware that calling the proposed effect ‘a likelihood model’ does not really fit with the Bayesian statistics used for the analyses where the likelihood refers to the observed data

**This is an interesting suggestion! We agree that next to being a methodological tool, the Bayesian framework could also be used as a theoretical tool to further our understanding of source credibility effects (for similar proposal, see [12]). We understand that the mentioning of the ‘elaboration likelihood model’ in our theoretical introduction, may appear at odds with the Bayesian approach that is applied in the statistical analysis of the study. The ELM was discussed mostly because it has been an influential theoretical framework in the history of the literature on persuasion. That being said, we acknowledge that next to the dual-process ELM, there are alternative theoretical models (including Bayesian ones) that might even provide a better characterisation of the processing of source information. While the process of knowledge updating based on incoming information is not the primary topic of this paper, we now include a short discussion of alternative (Bayesian) models to account for source credibility effects as well. Also note that while the Bayesian framework provides a useful account of belief updating in relation to source effects, it can-not be directly applied to our experimental paradigms, in which participants were exposed to information from the two different sources only once.**

**Concretely, we rewrote the sentence about the elaboration likelihood model by keeping it more general and removing the term itself (page 3, lines 78–80):**

**The combination of a credible authority and intangible information can increase the probability of obscure scientific information being accepted, by enhancing perceivers’ reliance on the source<sup>13–15</sup>.**

**Second, we added the following paragraph about Bayesian belief updating on page 3/4, lines 114–125:**

To account for these effects, next to traditional dual-process models of persuasion<sup>13,14,16,17</sup>, various authors have recently proposed a Bayesian framework in which subjective beliefs about the source (e.g., trustworthiness) and one’s worldviews contribute to belief updating in response to new information following Bayesian principles<sup>18–21</sup>. By including background beliefs, these Bayesian networks describe how a differential weighing of evidence and even divergent updating (belief polarization) can be considered rational and normative. This may explain, for instance, how strong religious believers can become more convinced of their beliefs in the face of disconfirmatory evidence, especially when their faith is being challenged<sup>19,22</sup>. Similarly, strong conservatives who distrust science may become less convinced of human-caused global warming when presented with scientific consensus information<sup>18</sup>. In other words, laypeople may apply their own ‘power priors’<sup>23</sup> to calibrate evidence from different sources, whose trustworthiness is subjectively determined, partly by their broader worldview.

**This framework could also account for the findings in our study, showing that people process information in line with their prior beliefs and expectations about the source. However, while we agree that laypeople may apply their own ‘power priors’ to weigh evidence differentially depending on their subjective beliefs about the source, we don’t think this is directly related to the ‘prior elicitation’ literature. To our knowledge, prior elicitation involves a process of actively selecting experts and weighing the contribution of different pieces of evidence to arrive at an informed prior distribution<sup>24,25</sup>. Here, on the other hand, we just presented a statement + source and participants could only passively use the source information to evaluate the statement, rather than select experts to generate ‘priors’ and weigh these (i.e., there was only one “expert” per statement). We thus decided not to include a reference to this literature in our paper.**

[R 1.4] On lines 174-176 the authors misinterpret the Bayesian results. If the BF between two models is approximately one, then the support in the data for both models is (almost) identical. That should then be your conclusion. Simplicity is already part of the Bayes Factor. Hence, it means the data-generating model was not part of the models tested. You cannot select one of those models because it fits your conclusions better.

**We acknowledge that we phrased this conclusion about the difference in evidence for the common effect and varying effects model somewhat awkwardly and incorrectly. Both models fit our conclusions equally well (i.e., evidence that the interaction effect is present across all countries). (Also note that the exact numbers slightly changed as per your suggestion we reconsidered and removed some covariates from the models; see below). We rephrased the sentences as follows (page 6/7, lines 188–193**

For hypothesis 2, the model comparison summarized in Table 1 shows that the data provide most evidence for the *common source-by-religiosity interaction model*, which assumes a consistent interaction effect across countries,  $BF_{10} = 0.99 \times 10^{15}$ . The data are uninformative for distinguishing between the common interaction and the varying positive interaction model ( $BF_{1p} = 1.28$ ), indicating that both are equally plausible. While we cannot conclude whether or not the size of the interaction effect differs substantially between countries, both models provide strong evidence for a source-by-religiosity effect across all countries.

[R 1.5] It was not clear to me why SES and level of education were used as covariates.

**We thank the reviewer for drawing our attention to the covariate selection. Initially, we included all measured variables which the literature suggests are related to religiosity (i.e., age, gender, SES, level of education) as well as any experimental factors that varied between participants (i.e., statement version and presentation order). However, we realized that many of these covariates were unnecessary (or potentially harmful) for causal inference. Please see the Appendix for details on the causal assumptions and covariate selection (including graphical models). In the methods we included the following revision (page 19, lines 513–528):**

In order to systematically investigate which third variables should and should not be included in the statistical model, we used *directed acyclic graphs* (DAGs<sup>26</sup>) to visually represent the causal relations between the variables in our data<sup>27–29</sup>. In short, this method entails specifying directed relations (arrows) between different constructs and measures (nodes) in a given design, that allow one to intuitively reflect causal structures and determine which third variables should be accounted for and which should be ignored in the statistical model. Based on DAGs created in the R package *ggdag*<sup>30</sup>, both *country* and *level of education* were identified as potential confounding factors that warranted inclusion, as they may affect both religiosity<sup>31,32</sup> and overall credibility assessments (e.g., due to skepticism). Country was therefore added as a clustering factor, while level of education was added as a fixed covariate in all models. We also ran the models while including all participant-level variables related to the primary measures, i.e., gender<sup>33</sup>, age<sup>34</sup>, SES<sup>35,36</sup>, statement version (A or B), and presentation order (guru–scientist or scientist–guru). Note that including these covariates improved the model fit, but the qualitative results remain the same regardless of the (set of) covariates. See the Appendix for details on the causal graphs and Table ?? for the primary results without any and with all covariates.

[R 1.6] Are the correlations mentioned on lines 135–139 also obtained via Bayesian statistics? If so, please provide credibility intervals and specify which Bayesian software has been used.

**We thank the reviewer for noting this omission. We now added credible intervals and a reference to the method used to estimate the correlation (i.e., van Doorn et al., 2020; page 4/5, lines 151–153).**

The two dependent variables that were measured (i.e., *importance* of the message and *credibility* of the message) were highly correlated for both the scientific source (Spearman's  $\rho = 0.772$ , 95% credible interval [0.764, 0.779]) and for the spiritual source (Spearman's  $\rho = 0.827$ , 95% credible interval [0.822,

0.833]; see Figure 9)<sup>37</sup>. As the qualitative results were equal across the dependent variables, we decided to only describe the findings for *credibility* in detail (see Table 2 for the results for *importance*).

[R 1.7] The  $M_0$  model should be an empty model without any predictors.

**In our statistical approach, which we pre-registered prior to the study, we adjusted the  $M_0$  to reflect the null-model for the specific hypothesis of interest. For the first hypothesis, for instance, we aimed to test the experimental effect of the source predictor. The null-model for this test should thus include the necessary background variables, that may explain variance but are not part of the manipulation. Therefore, the  $M_0$  for the first hypothesis includes a varying intercept per country, varying effect of individual religiosity and covariate ‘level of education’ (see Table 1). We believe a null-model including no predictors at all is not helpful for answering the question of whether the source manipulation affects credibility ratings. We also note that we report all analyses excluding covariates, which show that our main effects of interest hold irrespective of whether the covariates are included in the null-model.**

[R 1.8] Information about the intraclass correlation is missing. How much of the variance is actually located at the country level? Also, explained variances on both levels should be reported for each of the models.

**We added these metrics for all models in the Appendix (see the table below). We report the explained variance for the full model and the marginal explained variance for the fixed effects only, based on the method described by Gelman et al. (2019). While these metrics are useful for understanding the data and models, we don’t think they are crucial for our results and interpretation (e.g.,  $R^2$  will always favor models with more parameters, as they do not penalize for model complexity). Nevertheless, we think it is useful to add them in the Supplements and make a reference in the main text (see footnote 2 on page 6).**

*In the Appendix:*

#### Additional Model Statistics

For each of the models included in the analyses, we calculated the intraclass correlation (ICC; proportion of the total variance that is accounted for by the clustering) and the explained variance ( $R^2$ ). Explained variance was assessed using the `bayes_R2` function from the `rstantools` package<sup>38</sup>, based on the method described by Gelman et al.<sup>39</sup>. Explained variance is given separately for general  $R^2$  (all common and varying effects included in the respective model) and for the marginal  $R^2$  (the common effects only). The means and 95% credible intervals for each of the relevant models described in the main text are given in Table 1.

[R 1.9] Was a model with only the covariates tested? This model would be needed to check how much additional variance the predictors explain.

**In our  $M_0$  covariates were already included, so we could specifically test the evidence that the data provide for the predictor of interest.**

[R 1.10] Information of establishing convergence is lacking, which metrics did the authors use to make sure the chains reached the target distribution for the all post-burn-in iterations?

**In general, the BayesFactor package has been extensively tested for stability and convergence (which is the upside of the relatively limited flexibility compared to models in Stan or brms). Either way, we agree that information on some MCMC diagnostics would be appropriate. We now added metrics for split- $R^{40}$  based on the rank-based method described in Vehtari et al.<sup>41</sup>, as well as number of effective samples for each parameter in the full model in the Appendix:**

To investigate convergence of the MCMC chains, we calculated split- $R^{40}$  based on the rank-based method described in Vehtari et al.<sup>41</sup>. The smallest and largest  $R^{\wedge}$  values were 0.99997 and 1.00040, respectively, indicating good within-chain convergence. The traceplots for these smallest and largest values are shown in Figure 1a and b.

The number of effective samples ( $N_{eff}^{\wedge}$ ) was calculated per parameter to assess to what extent autocorrelation in the chains reduces the certainty of the posterior estimates<sup>42</sup>. Ideally,  $N_{eff}^{\wedge}$  is as large as possible<sup>41</sup>. The  $N_{eff}^{\wedge}$  for each of the 107 estimated parameters is displayed in Figure 1c. Note that  $N_{eff}^{\wedge}$  can be larger than the total number of iterations (in this case:  $N = 30,000$ ) when the samples are anti-correlated or antithetical<sup>43</sup>. The smallest  $N_{eff}^{\wedge} = 24,210.67$  for the varying slope of the source-by-religiosity interaction for Croatia. For many parameters,  $N_{eff}^{\wedge}$  is equal to the number of iterations or even higher. We therefore concluded that the effective sample size is sufficient for valid interpretation of the estimates and inference.

Table 1: Explained variance and intraclass correlation for all relevant models.

|                               | $R^2$ |                | Marginal $R^2$ |                | Intraclass correlation |                |
|-------------------------------|-------|----------------|----------------|----------------|------------------------|----------------|
|                               | Mean  | 95% CI         | Mean           | 95% CI         | Mean                   | 95% CI         |
| <b>Common Effect Models</b>   |       |                |                |                |                        |                |
| Source Effect                 | 0.173 | [0.165, 0.182] | 0.076          | [0.060, 0.094] | 0.125                  | [0.079, 0.198] |
| Source-by-Religiosity         | 0.181 | [0.172, 0.190] | 0.081          | [0.062, 0.102] | 0.142                  | [0.095, 0.213] |
| Processing Time               | 0.107 | [0.099, 0.114] | 0.015          | [0.012, 0.020] | 0.147                  | [0.091, 0.235] |
| Memory Performance            | 0.098 | [0.090, 0.105] | 0.004          | [0.002, 0.006] | 0.128                  | [0.078, 0.207] |
| Source Effect Trust           | 0.229 | [0.226, 0.232] | 0.141          | [0.139, 0.143] | 0.110                  | [0.089, 0.134] |
| Source-by-Religiosity Trust   | 0.281 | [0.278, 0.284] | 0.133          | [0.110, 0.157] | 0.293                  | [0.258, 0.332] |
| <b>Varying Effects Models</b> |       |                |                |                |                        |                |
| Source Effect                 | 0.179 | [0.170, 0.187] | 0.077          | [0.058, 0.099] | 0.150                  | [0.103, 0.220] |
| Source-by-Religiosity         | 0.182 | [0.174, 0.191] | 0.082          | [0.064, 0.101] | 0.141                  | [0.095, 0.212] |
| Processing Time               | 0.108 | [0.100, 0.115] | 0.015          | [0.011, 0.020] | 0.152                  | [0.097, 0.238] |
| Memory Performance            | 0.099 | [0.091, 0.106] | 0.004          | [0.002, 0.006] | 0.134                  | [0.085, 0.210] |
| Source Effect Trust           | 0.281 | [0.278, 0.283] | 0.133          | [0.110, 0.157] | 0.296                  | [0.261, 0.334] |

*Note.* Explained variance, split into general explained variance and marginal explained variance (fixed effects only), and intraclass correlations. The 95% CI gives the lower and upper bound of the credible interval. Note that there was no varying effect of the source-by-religiosity interaction for the trust model (validation dataset).

## Comments by Reviewer 2



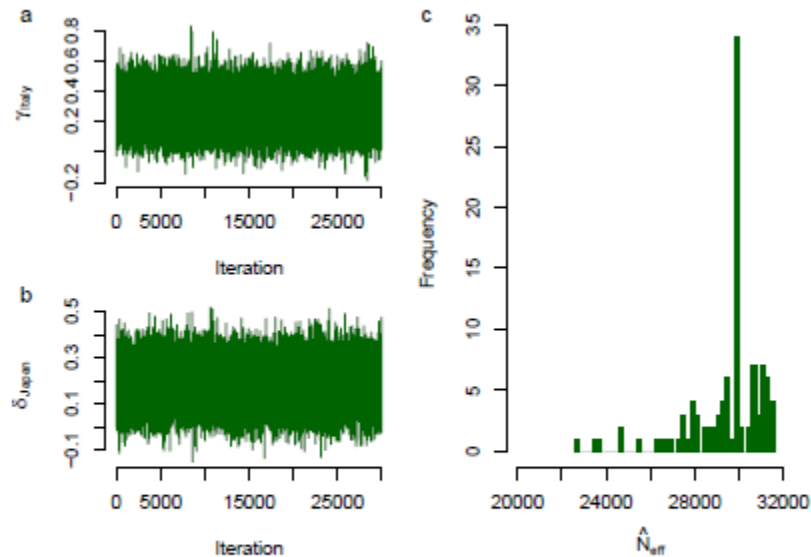


Figure 1: MCMC diagnostics. **a** Chains for parameters with the smallest (varying slope for source effect in Italy) and **b** largest (varying slope for the religiosity effect in Japan)  $\hat{R}$  values. **c** Number of effective samples for each parameter in the full model.

[R 2.1] I very much like this paper. To be honest, I can see little to prevent publication as it is. It is methodologically appropriate and the procedures are preregistered and transparent.

One caveat I would suggest the authors add is that although the experimental part of the design allows for attribution of causal effects, the fact that the sampling is essentially convenience wrt the countries involved, means that making country comparisons is something to be done with caution. It is good that there is a comparator analysis carried out on the additional survey data, but the country specific results are not really compared here in a visible way. Could they be?

**We agree with the reviewer that caution is warranted in drawing conclusions based on the country-specific effects and comparisons. We already made this explicit in the discussion (see page 12/13, lines 313–318). Regarding the comparison between the experimental source effect and source contrast in the validation dataset, we agree that this would be interesting to investigate. At the same time, however, we only have 24 data points for cross-country comparisons, which makes interpretation and statistical inference somewhat unreliable. We now added a visual display of the relation between the source effects in both datasets per country, as well as an exploratory correlation analysis in the Appendix. We emphasize that these findings should be interpreted with caution, as we have few observations and different sampling strategies and methods were used.**

To explore the country-level patterns in the source effect across both datasets, we assessed the correlation between the experimental source credibility effect in the primary dataset and the contrast of the trust ratings for scientists and traditional healers in the validation dataset per country. The raw observed relation as well as the relation between the modeled source effects are depicted in Figure 2a and b. The plots do not suggest a strong correlation between source effects, which is corroborated by the evidence for the correlation:  $BF_{+0} = 1.06$ ;  $BF_{+0} = 0.97$  for the observed and estimated source effects, respectively. These Bayes factors imply ‘absence of evidence’, meaning that we cannot conclude whether or not the country-level source effects are related between the two datasets. The 95% credible intervals further support the uncertainty of the correlation:  $\rho_{obs} = 0.17 [-0.22, 0.52]$ ;  $\rho_{est} = 0.15 [-0.22, 0.50]$ . We note however, that in addition to the uncertainty related to the small number of observations<sup>1</sup>, caution is also warranted due to the difference in included samples and exact items (credibility of specific nonsense statements vs. explicit trust in authorities) between datasets.

<sup>1</sup>These were the 24 countries from the main dataset minus China, for which no religiosity data was available in the validation dataset.

[R 2.2] The controls for confounding on the measured religiosity score are reasonable, although other correlates of religiosity, especially conservative or authoritarian worldviews cannot be ruled out as forming part of the reason for the observed source/religion interaction.

**We agree that religiosity is likely associated with related worldviews such as political orientation and authoritarianism. To address this issue, we added the following in the discussion (page 14, lines 372–379).**

This effect might not be unique to religiosity per se; in fact, we expect that known correlates of religiosity, such as conservatism and authoritarianism<sup>44–46</sup>, are also predictive of the source credibility effect for scientists vs. spiritual gurus. At the same time, our results showed that religiosity was mostly related to evaluation of statements from the guru and much less to those from the scientist. It would be interesting to see whether this pattern also occurs for worldviews that are less directly related to beliefs about spirituality. For instance, conservatism might be equally predictive of the magnitude of the source effect, yet driven by differences in credibility of scientists rather than gurus.

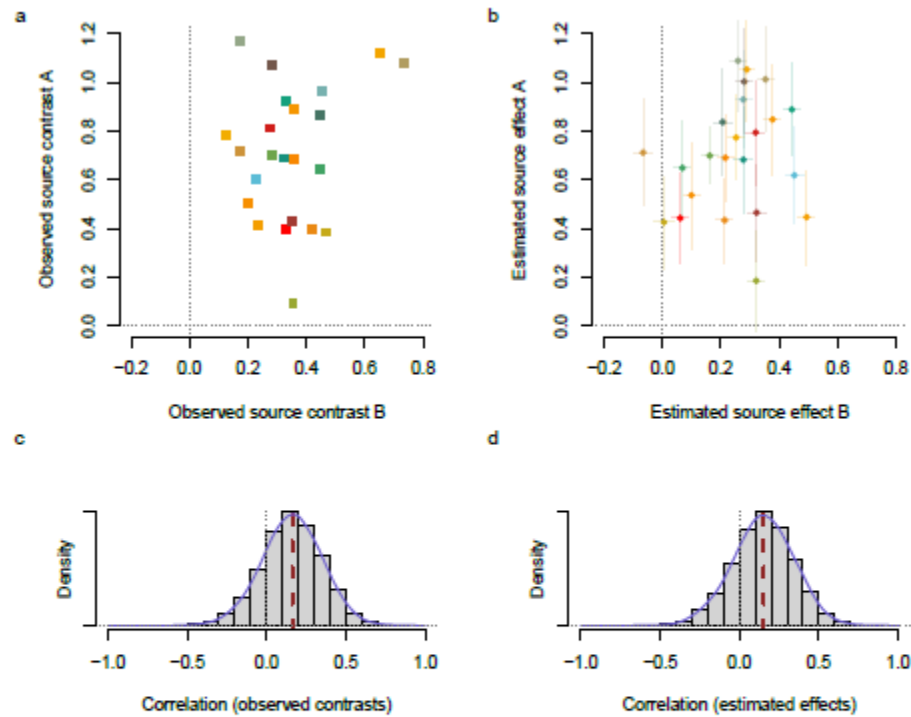


Figure 2: Correlation between the source effect in the new experimental dataset (set A) and the validation survey data on trust (set B). Panel **a** shows the relationship between the observed contrast effects (scientist minus guru) in both datasets. Each square represents a country. Panel **b** shows the country-level estimates (medians) of the source effect in the experimental dataset and the validation dataset. Each dot represents a country. The horizontal and vertical lines denote the 95% credible intervals. Panels **c** and **d** display the posterior distribution of the correlation coefficient  $\rho$  using the observed contrasts and estimated effects, respectively. The vertical dashed line reflects the median value for  $\rho$ .

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**Decision Letter, first revision:**

17th May 2021

Dear Ms Hoogeveen,

Thank you once again for your manuscript, entitled "The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity," and for your patience during the peer review process.

Your manuscript has now been evaluated by 2 reviewers, whose comments are included at the end of this letter. While Reviewer 1 has already reviewed the manuscript during the initial round of review, Reviewer 4 was recruited to replace Reviewer 2, who was unable to re-review your manuscript. Although the reviewers find your work to be improved, they also raise some important concerns. We remain very interested in the possibility of publishing your study in *Nature Human Behaviour*, but would like to consider your response to these concerns in the form of a revised manuscript before we make a decision on publication.

To guide the scope of the revisions, the editors discuss the referee reports in detail within the team, including with the chief editor, with a view to (1) identifying key priorities that should be addressed in revision and (2) overruling referee requests that are deemed beyond the scope of the current study. We hope that you will find the prioritised set of referee points to be useful when revising your study. Please do not hesitate to get in touch if you would like to discuss these issues further.

1) Reviewer 4 raises important concerns about the conceptualization of the investigated effect. In your revised manuscript, more explicitly position your work within the literature and discuss the distinction between the "Einstein effect" and the "Guru effect".

2) Moreover, Reviewer 4 suggests that the appearance of the individuals used in the stimuli as well as cultural differences in the construal of a "spiritual leader" might have affected the results. Please carefully evaluate these concerns and address them appropriately, including conducting robustness checks if possible.

3) In response to the comments by Reviewer 1, we ask you to revise the manuscript to acknowledge that the intraclass correlation coefficients suggest moderate effects only (despite large Bayes Factors).

4) Please assure that all links to the open-science framework are set to public.

Finally, your revised manuscript must comply fully with our editorial policies and formatting requirements. Failure to do so will result in your manuscript being returned to you, which will delay its consideration. To assist you in this process, I have attached a checklist that lists all of our requirements. If you have any questions about any of our policies or formatting, please don't hesitate to contact me.

In sum, we invite you to revise your manuscript taking into account all reviewer and editor comments. We are committed to providing a fair and constructive peer-review process. Do not hesitate to contact us if there are specific requests from the reviewers that you believe are technically impossible or



unlikely to yield a meaningful outcome.

We hope to receive your revised manuscript within four to eight weeks. We understand that the COVID-19 pandemic is causing significant disruption for many of our authors and reviewers. If you cannot send your revised manuscript within this time, please let us know - we will be happy to extend the submission date to enable you to complete your work on the revision.

With your revision, please:

- Include a "Response to the editors and reviewers" document detailing, point-by-point, how you addressed each editor and referee comment. If no action was taken to address a point, you must provide a compelling argument. This response will be used by the editors to evaluate your revision and sent back to the reviewers along with the revised manuscript.
- Highlight all changes made to your manuscript or provide us with a version that tracks changes.

Please use the link below to submit your revised manuscript and related files:

**[REDACTED]**

**Note:** This URL links to your confidential home page and associated information about manuscripts you may have submitted, or that you are reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage.

We look forward to seeing the revised manuscript and thank you for the opportunity to review your work. Please do not hesitate to contact me if you have any questions or would like to discuss these revisions further.

Sincerely,

Samantha Antusch  
Editor  
Nature Human Behaviour

Reviewer expertise:

Reviewer #1: Bayesian statistics ; social psychology

Reviewer #4: trust in science

REVIEWER COMMENTS:

Reviewer #1:  
Remarks to the Author:

I very much appreciate the extensive replies to my concerns and I am extremely happy with the new DAGs! Nice!

I have only some very minor suggestions:

Thank you for opening up the information on the open science framework. I only have a small remark: The registered form is available at <https://osf.io/xg8y5> but the link under Registered from [osf.io/dj6ck](https://osf.io/dj6ck) is still private and it seems some information is missing on the page itself.

I very much appreciate the long reply to my Covid-related question. I can imagine the extended information in the rebuttal letter might be informative for the readers of your paper. I leave it up to the editor whereas this is a good recommendation and to put this information in the appendix (or a footnote).

Concerning the ICC, I think it might be helpful to refer to the ICCs in Figure 1. I would even suggest to put Table 5 in the main document since it is relevant information about how much variance there is to be explained by the predictors. The ICC ranges between 11%-29% and some outcomes only explain 9-28% out of the available 11-29%. Two observations can be made here: first, most of the variance is located at the lower level and second, only a moderate part of the variance was explained. So, although the BFs are quite impressive the estimates display only moderate effect. This is not of a problem, but I believe this is important information which should be discussed in the main text. Also, I suggest to add some nuance in the discussion section taking these findings into account.

I would suggest to refer more often to the wealth of information provided in the supplementary materials!

Reviewer #4:

Remarks to the Author:

First of all, I want to disclose to authors that I am a new reviewer, so I will bring up a few additional points that have not been mentioned in previous rounds of review. Please forgive this approach, which is chosen with the best intentions. Also, I am more of a trust researcher than an expert on Bayesian statistics (I will leave this to the other reviewers, who have already made excellent points).

I want to join the two other reviewers in praise about the research question and execution of this study. You have chosen quite a straight-forward approach for testing their research question, which I applaud, and went on to take good care of making sure the country-comparison is set on solid grounds. Further strengths of the study are sample size and how authors deal with deviation from their preregistration. However, I want to make a few notes about the term "Einstein Effect" and study design/transparency of materials.

1. I am hesitant with the term "Einstein effect" – and whether it really summarizes what you found. I get that you're going at finding out if people go by the epistemic authority of science vs. religion (by the way, Kruglanski et al., 2005 have quite interesting findings that might inform your conclusions), but: Are you finding out about people's judgments of scientists as epistemic authority - or are you finding something out about religious vs. non-religious people and their judgments of different epistemic authorities (obviously, I think the latter is the case)? In other words: Are you finding out if

scientists are a universal epistemic authority, or whether it depends on deference to a societal system (e.g., towards science vs. religion) whether a source is an epistemic authority?

To explain: One could have measured deference to science (Howell et al., 2020) or a related concept, in addition to religiousness, to test whether this influences credibility ratings toward scientists in the same way as religiousness influences ratings of religious leaders. If this was the case, I think the term “Einstein effect” would be unwarranted.

In this way, I agree with the comment R 1.2 by reviewer 1: your study shows that people might readily accept scientists as epistemic authorities – but for pseudo-profound bullshit statements. In recent years, numerous studies in the context of science-, climate-, and health communication have shown that people judge the trustworthiness of scientists depending on numerous cues (source cues such as affiliation, pertinence of the scientist’s expertise to the topic/message cues such as scientificness, jargon, disclosed uncertainty etc.). That people are ready to make such judgments (beyond using heuristics such as the one you are looking at) – as long as they get the relevant cues – should be stated somewhere in your paper. This also goes well with comment R 1.3 and studies by Corner and colleagues, e.g. (Corner & Hahn, 2009).

2. For these reasons, I also do not completely understand the reasons for labeling it Einstein effect vs. Guru effect? There is only one line of reasoning that I can think of, but you don’t say that explicitly: Dan Sperber used the word “Guru”. While you found people are ready to believe a “well established authority, for example in the sciences” (could be philosophers as well, but you don’t test that), you also found that for religious leaders, it depends on people’s religiousness, so “guru” doesn’t seem the right name for the effect. So, you want change the terminology, and it is scientists for now until someone extends this to other possible epistemic authorities (or not). Is this what you meant?

3. Furthermore, on page 3, you mix the argumentation on the Guru effect and trustworthiness of spiritual leaders, which might be confusing to readers, because it might seem that Sperber meant only spiritual leaders when saying “guru”, which I believe is not true. This is further enhanced by switching terminology from “religious leader” to “guru”. I would suggest sticking with the wording in the experiment (see also, point 4 below).

4. Another concern addressed the pictures you used: Could they partially account for the effects? That is, could people have known the depicted men? And could the two depicted men’s appearance (hairstyle, scarf vs. tie etc) be partially responsible for the observed effects? There are (admittedly, rather aged) studies showing effects of attractiveness, clothing etc. on source credibility ratings. Was there an item measuring this, which could be included in the robustness checks? Did you pilot in different countries how well-known both men were? If not, this should be clearly stated as a limitation, unless you have presented pictures at random.

5. You explain that differences between countries were observed for the spiritual leader, but basically not for the scientist. Your explanations for this are easy to follow, but I would argue that the wording especially in different languages for “spiritual leader” might not have the same connotations across cultures, depending on the translation (note that this point goes slightly beyond your discussion of culture in some Asian countries). Being German, I can only imagine what a translation might be – most have very strange/negative connotations (“guru” has a somewhat negative meaning, as well). I cannot find the translations of statements and wordings in the materials for your study, but they could be easily disclosed either in the supplement or in osf. Did all participants receive an English version of the materials? How was “spiritual leader” translated? Did you test / pilot people’s understanding of the terminology used?

I sign my review:  
Kind regards,  
Friederike Hendriks

Corner, A., & Hahn, U. (2009). Evaluating science arguments: evidence, uncertainty, and argument strength. *Journal of Experimental Psychology: Applied*, 15(3), 199–212.

<https://doi.org/10.1037/a0016533>

Howell, E. L., Wirz, C. D., Scheufele, D. A., Brossard, D., & Xenos, M. A. (2020). Deference and decision-making in science and society: How deference to scientific authority goes beyond confidence in science and scientists to become authoritarianism. *Public Understanding of Science*, 096366252096274. <https://doi.org/10.1177/0963662520962741>

Kruglanski, A. W., Raviv, A. A., Bar-Tal, D., Raviv, A. A., Sharvit, K., Ellis, S., Bar, R., Pierro, A., & Mannetti, L. (2005). Says Who?: Epistemic Authority Effects in Social Judgment. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology* (Vol. 37, pp. 345–392). Elsevier Academic Press. [https://doi.org/10.1016/S0065-2601\(05\)37006-7](https://doi.org/10.1016/S0065-2601(05)37006-7)

Sperber, D., Clément, F., Heintz, C., Mascaro, O., Mercier, H., Origgi, G., & Wilson, D. (2010). Epistemic vigilance. *Mind and Language*, 25(4), 359–393. <https://doi.org/10.1111/j.1468-0017.2010.01394.x>

**Author Rebuttal, first revision:**

## Prioritised Set by the Editor

[E 1] Reviewer 4 raises important concerns about the conceptualization of the investigated effect. In your revised manuscript, more explicitly position your work within the literature and discuss the distinction between the “Einstein effect” and the “Guru effect”.

We are happy to reflect on and clarify the “guru effect” and the “Einstein effect” here and in the manuscript. Both the Einstein and the guru effect refer to the phenomenon where obscure speech from credible authorities is judged meaningful while not fully understood. We use the term “guru effect” because that term has become associated with the phenomenon in both the scientific literature and in the popular media (google has over 5000 hits for “guru effect”). We agree with Reviewer 4: the Einstein effect refers to the credibility of scientists given that they function as “gurus” for people within a particular culture. That makes the effect symmetrical to the guru effect: of course “gurus” too are only gurus within a particular cultural setting and for particular individuals.

We also acknowledge that the two effects can be differentiated; our reading of Sperber is that the guru effect entails that incomprehensible statements from credible sources can be judged profound *by virtue of their incomprehensibility*, which can often be observed in the speech of intellectual and spiritual gurus. For the Einstein effect, it might not be *by virtue of its incomprehensibility*, but *despite its incomprehensibility* that scientific information may be considered credible. Yet the key mechanism of the source lending credibility to the incomprehensible content remains the same. Hence, to investigate scientific epistemic authority, we contrasted judgements of gobbledegook spoken by a spiritual leader with gobbledegook spoken by a scientist. What we found – and what we dub the Einstein effect – is that the scientist is globally judged more credible, even by highly religious individuals.

In other words, we believe that our study addresses both how people judge scientists as epistemic authorities *and* how individual differences in religiosity are related to judgement of different epistemic authorities. The Einstein effect reflects that even when people don’t understand the information presented by a scientists, they still judge it credible, because they put credence in the scientific source. Our study also shows that this Einstein-effect is cross-culturally stable and prevalent, irrespective of one’s religious background.

We agree based on the above reasons, that the “guru effect” does not provide an accurate description of the effects we observed for our spiritual authority manipulation in our study. In order to avoid confusion on this topic, we exclusively use the term “guru effect” in the introduction, where we anticipate the theoretical background and rationale of our study, while we avoid using this term to describe the spiritual authority manipulation in our study.

Concretely, the following changes were made to the manuscript:

1. We rearranged the order of the introduction and describe the guru effect in relation to “credible sources boosting appreciation of incomprehensible information”, rather than in relation to source effects in a religious/spiritual context, in order to eliminate the confusion about the position of the guru effect within the literature and our study framework. Specifically, we added/rewrote the following (page 2/3 lines 64–73):

Knowing that a statement originates from an epistemic authority may thus increase the likelihood of opaque messages being interpreted as meaningful and profound. According to Sperber<sup>1</sup>, in some cases, incomprehensible statements from credible sources may be appreciated not just in spite of but *by virtue of* their incomprehensibility, as exemplified by the speech of spiritual or intellectual gurus (the “Guru effect”). Here, we investigate to what extent different epistemic authorities affect the perceived value of nonsensical information. To this end, we contrasted judgements of gobbledegook spoken by a spiritual leader with gobbledegook spoken by a scientist. In addition, we assessed whether the source effect is predicted by individual religiosity and varies cross-culturally, as a proxy for how scientists and spiritual authorities function as “gurus” for different individuals and within different cultural contexts.

2. We clarified the interest of the Einstein effect in the abstract (lines 36–38):

We found a robust global source credibility effect for scientific authorities, which we dub ‘the Einstein effect’: across all 24 countries scientists hold greater authority than spiritual sources, even among highly committed religious people, who are relatively also more credulous of nonsense from scientists than they are of nonsense from spiritual gurus.

3. ... and in the discussion (page 15 lines 386–387):

Notably, our study showed that across 24 countries even those who are highly religious are prone to a scientific source credibility bias, what we have deemed the Einstein effect.

4. In the introduction, we explicitly mentioned that there are more cues than epistemic authority that influence the perceived credibility of information (page 2 lines 55–57):

Children and adults are sensitive to the past track record of informants<sup>2–7</sup>, evidence of their benevolence toward the recipient of testimony<sup>8</sup>, as well as how credible the information is on its face<sup>9,10</sup>.

5. In the discussion, we added directions for future research addressing generalizability and causal mechanisms of the observed Einstein effect (page 15/16 lines 388–409).

Looking ahead, there are at least six compelling horizons for future research to address the generalizability and underlying causes of the Einstein effect. First, whether scientific education diminishes the appeal of scientific authority outside its immediate domain remains unclear. Although those



who place faith in science are prone to Einstein effects<sup>11–14</sup>, strong scepticism is normative within the practice of science – as anyone who has experienced peer-review will attest<sup>1</sup>. Second, future researchers might investigate whether political partisanship predicts differences in scientific-source credibility. Although political commitments may share common psychological features with religious commitments<sup>16–19</sup>, the rise of anti-science populist ideologies might diminish or reverse Einstein effects among political partisans. In contrast, individual differences in deference to science<sup>20</sup> may predict enhanced Einstein effects, although a recent study failed to find this pattern for faith in science<sup>21</sup>. Third, future work may extend the current work and investigate how the Einstein effect is affected by content cues (e.g., the use of jargon, argument coherence, disclosure of uncertainty<sup>22</sup>) and personal attitudes towards the topic<sup>23–25</sup>. Fourth, the historical origins of scientific source credibility across different cultures remain unclear. If we were to wind back the clock a century to Einstein’s era, would we also observe preferential source-credibility for scientific authority over spiritual authority? Fifth, the proximate and sustaining social and technological causes of scientific source credibility are not addressed in our study, and remain ripe for investigations. Is scientific source credibility an artefact of global information networks, country-wide science education, or the sequestering of religious authority to the private domain? Sixth, although our study covers 24 countries worldwide, we cannot claim universality for our findings. Indeed, investigating source credibility in cultures where spiritual authority dominates may help to clarify the mechanistic questions that our study raises but does not address.

[E 2] Moreover, Reviewer 4 suggests that the appearance of the individuals used in the stimuli as well as cultural differences in the construal of a “spiritual leader” might have affected the results. Please carefully evaluate these concerns and address them appropriately, including conducting robustness checks if possible.

This is an interesting point, that we have indeed given some consideration while we designed the study. Unfortunately, we did not ask whether participants recognized any of the depicted sources. In the discussion, we added this limitation and explain in a footnote how we tried to retrospectively assess recognition (page 14, lines 385–361 + footnote 5).

At the same time, we aimed to maximize the efficacy of our manipulation, by varying the names, photographs, and visual contexts (chalkboard vs. stars) in addition to the authorities’ profession. This approach makes it more difficult to single out which specific factor contributes to the source effect (e.g., the observed effects might be partly driven by the authorities’ appearance rather than their domain of expertise). Relatedly, some participants might have recognized the depicted men (Enrico Fermi and José Argüelles), although we consider it unlikely that many did.<sup>2</sup>

<sup>1</sup>Although it is 150 years after Charles Peirce famously argued for fixing beliefs from the “method of science” in favour of the “method of authority” the role of appeals to scientific authority among scientists remains unclear<sup>15</sup>.

<sup>2</sup>As we did not ask whether participants recognized any of the depicted sources, we tried to indirectly and retrospec-



We also did not conduct a separate pre-test of our stimuli to test for potential differences in attractiveness, science- or spiritual-like appearance etc. This would have been difficult, given the fact that these associations might also differ between the cultures that we tested in. Still, the consistency of the effect of our manipulation across all countries gives us confidence that it is very unlikely that the effects observed are driven by low-level features of the portrayed men alone.

In addition, although our financial resources did not permit us to pilot the materials in each country, we did make an effort to take the cultural specificity of the materials into account, by asking native speakers to translate and give feedback on the survey. Thus, participants conducted the study in their native language and did not have access to the English study material. We have made the surveys and stimuli in each language available on the OSF for readers to evaluate themselves (see page 18 lines 458–459 and lines 487–488) .

The full translated survey for each included country can be found at [osf.io/kywjs/](https://osf.io/kywjs/).

[...]

The stimuli in each language are provided at [osf.io/qsyvw/](https://osf.io/qsyvw/).

More generally, the cross-cultural equivalence vs. specificity balance always remains complicated in a study involving many countries. We agree that especially the concept of a ‘spiritual leader’ might have different connotations across cultures. In fact, the associations that people have with such a term might not be detachable from the perception of the sources and their domain of expertise. However, we are not aware of any empirical work on the linguistic perception of ‘spiritual authorities’ across cultures, so any suggestion would be highly speculative. For instance, while one could argue that spiritual leaders instill negative associations in secularized countries, as the Reviewer suggested, one could also imagine how spirituality is treated quite positively in secularized societies, because it is often interpreted as an (individualistic) alternative to organized religion (e.g., “spiritual but not religious”).

[E 3] In response to the comments by Reviewer 1, we ask you to revise the manuscript to acknowledge that the intraclass correlation coefficients suggest moderate effects only (despite large Bayes Factors).

We understand that there was some confusion about the ICC and explained variance ( $R^2$ ). As explained in the Appendix, For each of the models included in the analyses, we calculated the

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tively assess recognition by scanning the open text items at the end of the survey (comments and awareness item) for any mentioning of either ‘Enrico’, ‘Fermi’, ‘José’, or ‘Argüelles’ (ignoring capitalization or diacritical marks). Only one (Spanish) participant mentioned recognizing both of the sources. While this obviously does not prove no other participants might have known the depicted sources, it seems unlikely that this was the case for a large proportion of participants.

intraclass correlation (ICC; proportion of the total variance that is accounted for by the clustering) and the explained variance (Bayesian  $R^2$ ; proportion of the total variance that is accounted for by the effects). Please note that  $R^2$  is not a sub-component of the ICC, so explained variance of the models is not 9-28% out of 11-29%, but simply 9-28% (see our response to [R 1.3] for a more technical explanation). That being said, we're happy to clarify the metrics and to refer to them in the main text of the manuscript. Specifically,

1. in relation to Figure 1, we added a reference to the location of the observed variance (page 6 lines 175–177)

Also note that as shown in Figure 1 the within-country individual differences in credibility ratings are large, indicating that most of the variance is located at the lower level (i.e., the individual level).

2. we reported explained variance (Bayesian  $R^2$ ) for the best predictive model for each hypothesis.

Source effect (page 7 lines 172–173): [...] explained variance (Bayesian  $R^2$ ) of the model is 17.9%, 95% credible interval [17.0%, 18.7%].

Source-by-religiosity effect (page 7 line 195):  $R^2 = 18.1\%$  [17.2%, 19.0%].

Source effect trust data (page 8 line 243):  $R^2$  for the positive effects model = 28.1% [27.8%, 28.3%].

Source-by-religiosity effect trust data (page 8 line 253):  $R^2 = 28.1\%$  [27.8%, 28.4%].

3. we more clearly refer to the Appendix for details on the ICC and  $R^2$  for all models (page 6 lines 177–182).

The intraclass correlation coefficients (ICCs) quantifying the proportion of variance explained by the country clustering, as well as the total explained variance by the included effects for all models (Bayesian  $R^2$ ) are reported in the Appendix.

Also note that the Bayes factors reflect the evidence for the presence / absence of an effect; the fact that they are very large is (partly) due to the large amount of data, but not directly related to the size of the effects.

[E 4] Please assure that all links to the open-science framework are set to public.

Our apologies, the original page at [osf.io/dj6ck/registrations](https://osf.io/dj6ck/registrations) is now publicly accessible. The page itself is somewhat confusing as we uploaded documents as an ‘open-ended registration’. These documents (frozen and non-editable) can be found under ‘files’. We now added a note in the description of the OSF page on how to find them.

Comments by Reviewer 1

[R 1.1] I very much appreciate the extensive replies to my concerns and I am extremely happy with the new DAGs! Nice!

I have only some very minor suggestions:

Thank you for opening up the information on the open science framework. I only have a small remark: The registered form is available at <https://osf.io/xg8y5> but the link under Registered from [osf.io/dj6ck](https://osf.io/dj6ck) is still private and it seems some information is missing on the page itself.

Please see our response to the editor [E 4].

[R 1.2] I very much appreciate the long reply to my Covid-related question. I can imagine the extended information in the rebuttal letter might be informative for the readers of your paper. I leave it up to the editor whereas this is a good recommendation and to put this information in the appendix (or a footnote).

We agree that while not the primary concern of the paper, the relation with Covid might still be relevant for readers. We added it in the Appendix and notify the reader of this information in footnote 1 on page 2.

Please see the Appendix for a short commentary on how the present work might relate to the COVID-19 situation.

In the Appendix we included:

#### **A Note on Scientific Credibility and the COVID-19 Situation**

In the main paper, we included the case of COVID-19 only as a timely example to introduce our general topic, but we do not further elaborate on trust and credibility of authorities related to COVID-19 specifically. That is, we believe that our findings bear a broader and more general relevance for understanding source credibility-effects, that go beyond the current situation. Many others have investigated the perception of experts in relation to COVID-19 specifically in great detail, see for instance<sup>26–32</sup>. While we do not discuss COVID-19 at length in the main paper, we quickly reflect here on the potential implications of these findings, using the Netherlands as an illustration.

The pattern found in the studies referred to above is somewhat mixed, yet most data seem to suggest that trust in science/scientists has either remained the same or even increased during the pandemic. In the Netherlands for instance, the majority of the general public still places more trust in the Outbreak Management Team (OMT; a team of experts convened to advise the government on policy in the event of an outbreak of infectious disease) and RIVM (Dutch equivalent of the CDC) than Maurice de Hond or Willem Engel (Dutch public figures and self-declared COVID-19 experts).

This is, for instance, indirectly indicated by increased vaccination willingness over the last months (about 80% in NL). Moreover, the public still mostly relies on information regarding vaccination provided by vaccination centers (60.6%), the RIVM website (48.1%) and GPs (39.6%), to a stronger extent than that provided by the media (34.8%), trusted celebrities (2.5%) or social media (2%; see [www.rivm.nl/gedragsonderzoek/maatregelen-welbevinden/vaccinatiebereidheid](http://www.rivm.nl/gedragsonderzoek/maatregelen-welbevinden/vaccinatiebereidheid)). So while there are certainly individual differences in the perception of who is considered an expert, it seems that, on average, scientific expertise is still considered the most trustworthy source of information compared to other sources in relation to COVID-19 - and perhaps more generally as our study suggests.

[R 1.3] Concerning the ICC, I think it might be helpful to refer to the ICCs in Figure 1. I would even suggest to put Table 5 in the main document since it is relevant information about how much variance there is to be explained by the predictors. The ICC ranges between 11%-29% and some outcomes only explain 9-28% out of the available 11-29%. Two observations can be made here: first, most of the variance is located at the lower level and second, only a moderate part of the variance was explained. So, although the BFs are quite impressive the estimates display only moderate effect. This is not of a problem, but I believe this is important information which should be discussed in the main text. Also, I suggest to add some nuance in the discussion section taking these findings into account.

Please see our response to the editor [E 3]. In addition, following the work by Gelman et al. (2019)[33], our Bayesian  $R^2$  metric reflects the variance explained by both the fixed and random parts of the effects included in the models (i.e., variance of effects / total variance). The ICC reflects the variance explained by the clustering of the data, in this case the country in which individuals are located (i.e., (the variance of the random parts of the effects + the random intercepts) / total variance). Note that the ICC does not include the variance explained by the fixed part of the effects, only the deviation from the overall effects for each country. Thus, the ICC and  $R^2$  are partly overlapping (i.e., both include the random part of the effects), but also have distinct components (i.e., the random intercepts and the fixed part of the effects, respectively).

[R 1.4] I would suggest to refer more often to the wealth of information provided in the supplementary materials!

We thank the reviewer for this great suggestion. For most parts, we already included references in the results (dv correlation figure, ICC,  $R^2$ ) or methods (general project information; DAGs and causal graphs; H3 on cultural norms; brms results and comparison). However, we now additionally included references to: MCMC diagnostics, country-level estimates of intercepts and effects, analysis on correlation in effects between datasets, exact religiosity items, and the Covid-related comment.

- There [in the Appendix], we also report MCMC diagnostics to verify the adequacy of the Bayesian



models, as well as the estimates for the intercepts, source effect, and the source-by-religiosity interaction effect for each country. (page 6 lines 180–182)

- See the Appendix for an additional exploratory analysis on the country-level correlation in the source effect between the primary experimental dataset and secondary validation dataset on trust. (page 8 lines 261–263)
- (see the Appendix for the exact [religiosity] items). (page 18 lines 463–464)

## Comments by Reviewer 4

[R. 4.1] First of all, I want to disclose to authors that I am a new reviewer, so I will bring up a few additional points that have not been mentioned in previous rounds of review. Please forgive this approach, which is chosen with the best intentions. Also, I am more of a trust researcher than an expert on Bayesian statistics (I will leave this to the other reviewers, who have already made excellent points).

I want to join the two other reviewers in praise about the research question and execution of this study. You have chosen quite a straight-forward approach for testing their research question, which I applaud, and went on to take good care of making sure the country-comparison is set on solid grounds. Further strengths of the study are sample size and how authors deal with deviation from their preregistration. However, I want to make a few notes about the term “Einstein Effect” and study design/transparency of materials.

I am hesitant with the term “Einstein effect” – and whether it really summarizes what you found. I get that you’re going at finding out if people go by the epistemic authority of science vs. religion (by the way, Kruglanski et al., 2005 have quite interesting findings that might inform your conclusions), but: Are you finding out about people’s judgments of scientists as epistemic authority - or are you finding something out about religious vs. non-religious people and their judgments of different epistemic authorities (obviously, I think the latter is the case)? In other words: Are you finding out if scientists are a universal epistemic authority, or whether it depends on deference to a societal system (e.g., towards science vs. religion) whether a source is an epistemic authority? To explain: One could have measured deference to science (Howell et al., 2020) or a related concept, in addition to religiousness, to test whether this influences credibility ratings toward scientists in the same way as religiousness influences ratings of religious leaders. If this was the case, I think the term “Einstein effect” would be unwarranted. In this way, I agree with the comment R.1.2 by reviewer 1: your study shows that people might readily accept scientists as epistemic authorities – but for pseudo-profound bullshit statements. In recent years, numerous studies in the context of science-, climate-, and health communication have shown that people judge the trustworthiness of scientists depending on numerous cues (source cues such as affiliation, pertinence of the scientist’s expertise to the topic/message cues such as scientificness, jargon, disclosed uncertainty etc.). That people are ready to make such judgments (beyond using heuristics

such as the one you are looking at) - as long as they get the relevant cues - should be stated somewhere in your paper. This also goes well with comment R 1.3 and studies by Corner and colleagues, e.g. (Corner & Hahn, 2009).

We appreciate the thoughtful consideration of our paper and would like to thank the reviewer for their transparency and suggestions for literature. Please see our response to the editor at [E 1] for our rationale for this term and a more nuanced discussion of the scientific source credibility effect.

[R 4.2] For these reasons, I also do not completely understand the reasons for labeling it Einstein effect vs. Guru effect? There is only one line of reasoning that I can think of, but you don't say that explicitly: Dan Sperber used the word "Guru". While you found people are ready to believe a "well established authority, for example in the sciences" (could be philosophers as well, but you don't test that), you also found that for religious leaders, it depends on people's religiousness, so "guru" doesn't seem the right name for the effect. So, you want change the terminology, and it is scientists for now until someone extends this to other possible epistemic authorities (or not). Is this what you meant?

Please see our response to the editor [E 1].

[R 4.3] Furthermore, on page 3, you mix the argumentation on the Guru effect and trustworthiness of spiritual leaders, which might be confusing to readers, because it might seem that Sperber meant only spiritual leaders when saying "guru", which I believe is not true. This is further enhanced by switching terminology from "religious leader" to "guru". I would suggest sticking with the wording in the experiment (see also, point 4 below).

We understand the confusion about the terms, however, we have thought carefully about the terminology and we tried to be as consistent and in line with existing definitions as possible. Specifically, we tried to consistently refer to our stimulus as 'spiritual guru'. In our description of previous research, we tried to use the terms that were used in the respective studies (e.g., religious authority, spiritual leader etc.). Furthermore, we agree that Sperber's guru does not only refer to spiritual sources, but also intellectual gurus. In our description of Sperber, we remain neutral regarding the presumed background of the guru: ("According to Sperber, in some cases, incomprehensible statements from credible sources may be appreciated not just in spite of but by virtue of their incomprehensibility (the Guru effect).").

Regarding the religious leader, this is explained on page 4 lines 132–138: "Note that we chose a 'spiritual guru' authority frame, instead of 'religious leader,' because we wanted to avoid selecting an authority specific to any particular religion, to keep the study consistent across countries. While religiosity and spirituality are overlapping but not interchangeable constructs, self-reported religiosity has been positively associated with belief in spiritual phenomena such as fate, spiritual energy, and a connected universe (though not unequivocally). Consequently, we expected religiosity to be associated



with increased receptivity to gobbledegook from a spiritual authority.”.

[R 4.4] Another concern addressed the pictures you used: Could they partially account for the effects? That is, could people have known the depicted men? And could the two depicted men’s appearance (hairstyle, scarf vs. tie etc) be partially responsible for the observed effects? There are (admittedly, rather aged) studies showing effects of attractiveness, clothing etc. on source credibility ratings. Was there an item measuring this, which could be included in the robustness checks? Did you pilot in different countries how well-known both men were? If not, this should be clearly stated as a limitation, unless you have presented pictures at random.

Please see our response to the editor [E 2].

[R 4.5] You explain that differences between countries were observed for the spiritual leader, but basically not for the scientist. Your explanations for this are easy to follow, but I would argue that the wording especially in different languages for “spiritual leader” might not have the same connotations across cultures, depending on the translation (note that this point goes slightly beyond your discussion of culture in some Asian countries). Being German, I can only imagine what a translation might be – most have very strange/negative connotations (“guru” has a somewhat negative meaning, as well). I cannot find the translations of statements and wordings in the materials for your study, but they could be easily disclosed either in the supplement or in osf. Did all participants receive an English version of the materials? How was “spiritual leader” translated? Did you test / pilot people’s understanding of the terminology used?

Please see our response to the editor [E 3]. (NB. For your interest, the German translation of “spiritual leader” was “spiritueller Meister”.)

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**Decision Letter, second revision:**

Our ref: NATHUMBEHAV-201113440B

24th June 2021

Dear Dr. Hoogeveen,

Thank you for submitting your revised manuscript "The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity" (NATHUMBEHAV-201113440B). It has now been seen by the original referees and their comments are below. As you can see, the reviewers find that the paper has improved in revision. We will therefore be happy in principle to publish it in Nature Human Behaviour, pending minor revisions to satisfy the referees' final requests and to comply with our editorial and formatting guidelines.

We are now performing detailed checks on your paper and will send you a checklist detailing our editorial and formatting requirements in about a week. Please do not upload the final materials and make any revisions until you receive this additional information from us.

Please do not hesitate to contact me if you have any questions.

Sincerely,

Samantha Antusch

Samantha Antusch, PhD  
Editor  
Nature Human Behaviour

Reviewer #4 (Remarks to the Author):

In this revised version of the manuscript the authors have addressed the reviewer comments nicely (again, I leave the methodological issues to the other reviewer), and I commend them for being so thorough in their response. I have only one minor comment.

The authors have reflected on the term "Einstein Effect" in their response and now more clearly define the "Einstein Effect" in the abstract and introduction of their manuscript to clarify that this study is about the difference of scientific expert vs. spiritual leader. However, the research question still reads (line 130): "We assessed (1) whether trust in science is a general heuristic (i.e., the Einstein effect)". The study was designed to compare people's ratings on two information sources, their trust in/deference to science was not measured. This statement could be easily changed to "whether trusting scientific experts over religious leaders is a general heuristic" or "whether there is a source credibility bias favoring the scientist" to be more accurate (and no less interesting).

I appreciate that the authors now thoroughly discuss of the generalizability of the effect and have included a note on the origin (source appearance vs. profession) of the effect.

I sign my review. Kindly,  
Friederike Hendriks

**Decision letter, final requests:**

\*\* Please ensure you delete the link to your author homepage in this e-mail if you wish to forward it to your co-authors. \*\*

Our ref: NATHUMBEHAV-201113440B

30th June 2021

Dear Dr. Hoogeveen,

Thank you for your patience as we've prepared the guidelines for final submission of your Nature Human Behaviour manuscript, "The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity" (NATHUMBEHAV-201113440B). Please carefully follow the step-by-step instructions provided in the attached file, and add a response in each row of the table to indicate the changes that you have made. Please also check and comment on any additional marked-up edits we have proposed within the text. Ensuring that each point is addressed will help to ensure that your revised manuscript can be swiftly handed over to our production team.

We would like to start working on your revised paper, with all of the requested files and forms, as soon as possible (preferably within two weeks). Please get in contact with us if you anticipate delays.

When you upload your final materials, please include a point-by-point response to any remaining reviewer comments.

If you have not done so already, please alert us to any related manuscripts from your group that are under consideration or in press at other journals, or are being written up for submission to other journals (see: <https://www.nature.com/nature-research/editorial-policies/plagiarism#policy-on-duplicate-publication> for details).

Nature Human Behaviour offers a Transparent Peer Review option for new original research manuscripts submitted after December 1st, 2019. As part of this initiative, we encourage our authors to support increased transparency into the peer review process by agreeing to have the reviewer comments, author rebuttal letters, and editorial decision letters published as a Supplementary item. When you submit your final files please clearly state in your cover letter whether or not you would like to participate in this initiative. Please note that failure to state your preference will result in delays in accepting your manuscript for publication.

In recognition of the time and expertise our reviewers provide to Nature Human Behaviour's editorial process, we would like to formally acknowledge their contribution to the external peer review of your manuscript entitled "The Einstein effect: Global evidence for scientific source credibility effects and the influence of religiosity". For those reviewers who give their assent, we will be publishing their names alongside the published article.



## <b>Cover suggestions</b>

As you prepare your final files we encourage you to consider whether you have any images or illustrations that may be appropriate for use on the cover of Nature Human Behaviour.

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Please use the following link for uploading these materials:

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If you have any further questions, please feel free to contact me.

Best regards,  
Chloe Knight  
Editorial Assistant  
Nature Human Behaviour

On behalf of

Samantha Antusch

Samantha Antusch, PhD  
Editor  
Nature Human Behaviour

Reviewer #4:

Remarks to the Author:

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The authors have reflected on the term “Einstein Effect” in their response and now more clearly define the “Einstein Effect” in the abstract and introduction of their manuscript to clarify that this study is about the difference of scientific expert vs. spiritual leader. However, the research question still reads (line 130): “We assessed (1) whether trust in science is a general heuristic (i.e., the Einstein effect)”. The study was designed to compare people’s ratings on two information sources, their trust in/deference to science was not measured. This statement could be easily changed to “whether trusting scientific experts over religious leaders is a general heuristic” or “whether there is a source credibility bias favoring the scientist” to be more accurate (and no less interesting).

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I sign my review. Kindly,  
Friederike Hendriks

**Author Rebuttal, second revision:****Comments by Reviewer 4**

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**We followed the reviewer’s suggestion to change the wording of the research question to “We assessed (1) whether trusting scientific experts over spiritual leaders is a general heuristic”. (Note that we used ‘spiritual’ rather than ‘religious’ to accurately reflect our manipulation.)**

**Final Decision Letter:**

Dear Ms Hoogeveen,

We are pleased to inform you that your Article "The Einstein effect provides global evidence for scientific source credibility effects and the influence of religiosity", has now been accepted for publication in *Nature Human Behaviour*.

Please note that *Nature Human Behaviour* is a Transformative Journal (TJ). Authors whose manuscript was submitted on or after January 1st, 2021, may publish their research with us through the traditional subscription access route or make their paper immediately open access through payment of an article-processing charge (APC). Authors will not be required to make a final decision about access to their article until it has been accepted. IMPORTANT NOTE:

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We look forward to publishing your paper.

With best regards,

Samantha Antusch

Samantha Antusch, PhD

Editor  
Nature Human Behaviour