

Explaining the existential: Scientific and religious explanations play different functional
roles

Telli Davoodi¹

Tania Lombrozo¹

¹ Princeton University, Department of Psychology

*This manuscript is accepted for publication in the Experimental Journal of Psychology:
General*

Acknowledgements

This project was made possible through the support of a grant from the John Templeton Foundation. The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the John Templeton Foundation. We are grateful to Casey Lewry for help with coding, and other members of the Concepts and Cognition lab at Princeton University for insightful discussion. A subset of this work was presented at the 2020 meeting of the Cognitive Science Society, as well as the 2021 meeting of the Society for Philosophy and Psychology. Data and analysis codes for all studies reported in this paper are available at <https://osf.io/8ht46/>.

Abstract

How did the universe come to exist? What happens after we die? Answers to existential questions tend to elicit both scientific and religious explanations, offering a unique opportunity to evaluate how these domains differ in their psychological roles. Across three studies ($N = 1,647$), we investigate whether (and by whom) scientific and religious explanations are perceived to have epistemic merits – such as evidential and logical support – versus non-epistemic merits – such as social, emotional, or moral benefits. We find that scientific explanations are attributed more epistemic merits than are religious explanations (Study 1), that an explanation's perceived epistemic merits are more strongly associated with endorsement of that explanation for science than for religion (Study 2), and that scientific explanations are more likely to be generated when participants are prompted for an explanation high in epistemic merits (Study 3). By contrast, we find that religious explanations are attributed more non-epistemic merits than are scientific explanations (Study 1), that an explanation's perceived non-epistemic merits are more strongly associated with endorsement of that explanation for religion than for science (Study 2), and that religious explanations are more likely to be generated when participants are prompted for an explanation high in non-epistemic merits (Study 3). These findings inform theories of the relationship between religion and science, and they provide insight into accounts of the coexistence of scientific and religious cognition.

Keywords: explanations; existential questions; religious; scientific; religiosity; coexistence

Introduction

“I was an atheist, finding no reason to postulate the existence of any truths outside of mathematics, physics and chemistry. But then I went to medical school and encountered life and death issues at the bedsides of my patients. Challenged by one of those patients, who asked "What do you believe, doctor?", I began searching for answers...I had to admit that the science I loved so much was powerless to answer questions such as "What is the meaning of life?" ... "What happens after we die?"

– Francis Collins, American physician, geneticist, Director of the National Institute of Health, and a devout Christian.

Humans are inquisitive creatures. While many of our questions focus on the mundane, we also contemplate the existential: How did life, as we know it, come to be? What happens after we die? Why is there suffering? Such questions tend to inhabit the shared territory of science and religion, making them an ideal test case for investigating the psychological roles of scientific and religious explanations. Insofar as scientific and religious explanations satisfy our “existential curiosity,” do they do so in fundamentally different ways, playing fundamentally different roles?

In the current paper, we investigate scientific and religious explanations for the existential, focusing on their potential to play *epistemic* roles (e.g., accurately reflecting the causal structure of the world) versus *non-epistemic* roles (e.g., offering social, moral, or emotional benefits). Specifically, we test whether explanations from the domains of science and religion are differentially associated with epistemic versus non-epistemic merits, and we assess how such perceptions vary as a function of an individual’s own scientific and religious beliefs. Across three studies, we successfully differentiate between several models of how domain and belief shape an explanation’s (perceived)

epistemic and non-epistemic merits (Studies 1-2), and we show that epistemic versus non-epistemic goals shift the domain of explanation provided in response to an existential question (Study 3).

Characterizing the epistemic and non-epistemic roles of scientific and religious explanations is valuable for a number of reasons. Many models of secularization suggest that as science expands its explanatory scope (e.g., Larmore, 1996; Bruce, 2002; Chaves, 1994; Yamane, 1997), religion becomes restricted to non-epistemic roles, such as offering a sense of meaning (Larmore, 1996), facilitating social and community ties (Bruce, 2002), or coping with existential fears (e.g., Stark & Brainbridge, 1996). This suggests that scientific and religious explanations for the existential might play complementary epistemic and non-epistemic roles, respectively. But it also raises largely unanswered questions about how the religious regard the epistemic credentials of religious explanations (a topic we address in Studies 1-2), and about how the secular fulfill non-epistemic roles (a topic we address in Study 3).

More generally, our studies contribute to a growing literature on the psychological roles of scientific and religious cognition (Tetlock, 2002, 2003; Liquin, Metz, & Lombrozo, 2020; Van Leeuwen, 2014; McCauley, 2011), including the perceived co-existence versus competition between scientific and religious beliefs (Legare & Visala, 2011; Shtulman & Lombrozo, 2016). Understanding the perceived strengths and limitations of scientific explanations also has potential implications for science communication and for the public acceptance of science. To the extent that scientific explanations are perceived as deficient – either in general or by those with high levels of

religiosity – it is important to understand what drives these perceptions. For these reasons, we turn our curiosity to existential curiosity itself.

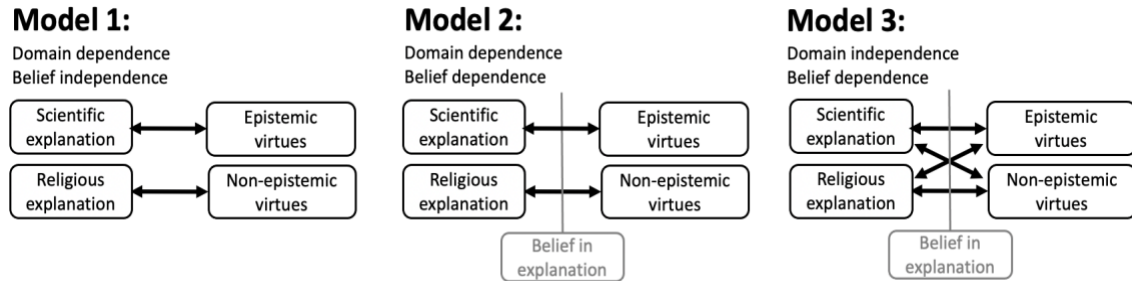


Figure 1. Three models, each depicting a possible set of associations between the domain of an existential explanation and whether it is attributed epistemic and non-epistemic virtues. Models 2 and 3 include a moderating role for belief, such that endorsement of a given explanation moderates the relationship between an explanation’s domain and the extent to which it is attributed epistemic or non-epistemic virtues. In Study 1, we operationalize belief in religious explanations through a measure of religiosity. In Study 2, we measure belief in a given explanation directly.

Evaluating Existential Explanations: Effects of Domain

Do scientific and religious explanations play fundamentally different roles? Within science, explanations aim to provide veridical descriptions of processes or regularities that support our understanding of the natural world and our ability to effectively predict and control it (Woodward, 2019; for similar points concerning folk

explanations, see Carey, 1985; Gopnik & Melzoff, 1997; Lombrozo, 2006). These roles can be characterized as broadly *epistemic*: scientific and folk-scientific explanations aim at capturing the truth, and criteria for evaluating explanation quality – such as evidential support, logical consistency, and causal accuracy – make sense in light of this aim.

At first blush, it is plausible that religious explanations play different roles, and are evaluated according to different criteria. Religious explanations are often connected to the creation of meaning and to emotional support (Newton & McIntosh, 2013; Batson & Stocks, 2004; Park, 2005). It is widely believed (by laypeople) that religious beliefs support moral behavior (Pew Research, 2007), and (by social scientists) that religious identities define the boundaries of social groups (Verkuyten, 2007; Argyle & Beit-Hallahmi, 1975; Batson & Burris, 1994). These observations suggest that religious explanations might play *non-epistemic* psychological roles – that is, roles related to emotional comfort, moral behavior, and community.

Prior work offers tentative evidence that science and religion indeed differ along epistemic and non-epistemic dimensions. Illustrating the former, scientific beliefs are more likely than religious beliefs to be justified by appeal to evidence (Metz, Liquin, & Lombrozo, in prep; Metz, Weisberg, & Weisberg, 2018; Shtulman, 2013), are more strongly associated with inquiry (Davoodi & Lombrozo, in prep; Liquin, Metz, & Lombrozo, 2020; Gill & Lombrozo, 2019), and are more likely to be perceived as objectively true (Heiphetz, Spelke, Harris, & Banaji, 2013; see also Heiphetz, Spelke, Harris, & Banaji, 2014; Friesen, Campbell, & Kay, 2015; Gottlieb, 2007). Perhaps reflecting these different attitudes towards belief, studies have found that across a number

of cultures, scientific beliefs tend to be held with greater confidence than religious beliefs (Harris et al., 2012; Harris et al., 2006; Davoodi et al., 2019; Cui et al., 2020).

On the side of *non*-epistemic roles, such as social, moral, and emotional support, studies find that religious explanations may enjoy an advantage over their scientific counterparts. For instance, religious beliefs are often endorsed more strongly after a threat to control (see Kay et al., 2008; Kay et al., 2009; Kay, Moscovitch, & Laurin, 2010; Laurin, Kay, & Moscovitch, 2008; Rutjens, van der Pligt, and van Harreveld, 2010) or a mortality prime (Norenzayan & Hansen, 2006; see also Vail et al., 2010; Jong, Halberstadt, & Bluemke, 2012), suggesting that religious beliefs buffer against induced (existential) anxiety. As noted already, religious beliefs also play a central role in many people's intuitive theories of what promotes moral behavior (Pew Research Center, 2014, 2017; Gervais et al., 2017; Wright & Nichols, 2014; see also Gervais, Shariff, & Norenzayan, 2011), and on many frameworks, are in fact tied to pro-social behavior (e.g., see Tsang, Rowatt, & Shariff, 2015; Oviedo, 2016). More indirect evidence for the non-epistemic role of religion is found in work showing that religious involvement influences social integration (Verkuyten & Yildiz, 2007), and signals social commitment and identity (see for example, Cadge & Ecklund, 2006; Freeman, 2003; Kinnvall, 2004; Cui et al., 2019).

Given these associations between science and epistemic virtues, on the one hand, and religion and non-epistemic virtues, on the other, we might expect a pattern like that depicted in Model 1 of Figure 1, whereby the domain of a given explanation (science vs. religion) is associated with the extent to which it is attributed epistemic virtues (such as

evidential support) versus non-epistemic virtues (such as supporting moral behavior). Such a pattern would be consistent with the work just reviewed, as well as many models of secularization. However, most empirical work has assessed epistemic and non-epistemic merits indirectly. Moreover, prior work has rarely contrasted religion and science within the same design, especially when it comes to assessing the non-epistemic dimensions of each domain. Finally, prior work has tended to focus on scientific and religious beliefs, rather than explanations per se. Many questions therefore remain unanswered about how the domain of an existential explanation relates to its perceived merits. In particular, it is unclear to what extent (and by whom) religious explanations are attributed epistemic virtues, and to what extent (and by whom) scientific explanations are attributed non-epistemic virtues.

Evaluating Existential Explanations: Effects of Belief

Even if scientific explanations are associated with epistemic virtues and religious explanations with non-epistemic virtues, on average, it is plausible that such patterns of association will depend on an individual's own beliefs, and more specifically on their endorsement of a given explanation. It is implausible that a Biblical literalist would credit an evolutionary explanation of human origins with strong evidential support, and unclear whether many atheists would credit a creationist explanation with moral benefits. Models 2 and 3 in Figure 1 depict two ways in which belief might moderate relationships between domain and explanatory virtues.

Model 2 introduces the simplest form of "belief dependence": people could consider an explanation's truth as a prerequisite to attributing domain-appropriate virtues.

Thus, scientific explanations will only be credited with evidential support, objectivity, and so on when they are judged true, and religious explanations will only be credited with social, moral, and emotional benefits when they are judged true. Model 3 introduces an alternative form of belief-dependence according to which endorsed explanations are credited with *both* kinds of virtues.

Prior work offers tentative support for Model 3 over Model 2. First, there is some evidence that for the religious, religious claims are not necessarily regarded as independent of evidential and other epistemic considerations, but instead accorded a lower threshold for evidence (McPhetres & Zuckerman, 2017), or supported by special kinds of evidence, such as religious authority, what one feels in one's heart, or a religious experience (e.g., Metz, Weisberg, & Weisberg, 2018; Shenhav, Rand, & Greene, 2012). On the flipside, there is some evidence that scientific beliefs – like religious beliefs – can offer a sense of control (Rutjens, van der Pligt, & van Harreveld, 2010; Rutjens et al., 2013), reduce existential anxiety (Farias et al., 2013; Tracy, Hart, & Martens, 2011), define cultural identity (Kahan, 2012; Kahan and et al., 2017), offer a sense of meaning (Rutjens & Van Elk, 2019, as cited in Rutjens & Preston, 2020), and support experiences of awe (Gottlieb, Keltner, & Lombrozo, 2018; Valdesolo, Park, & Gottlieb, 2016). While the conditions under which science has these consequences appear to be more limited than those for religion (see Rutjens & Preston, 2020, for a review), this nonetheless raises the possibility that secularization could entail not only the restriction of epistemic virtues to scientific explanations, but also the transfer of non-epistemic virtues from religious explanations to scientific ones. This contrasts with a more canonical account of

secularization (more consistent with Models 1 or 2), according to which the encroachment of science on the epistemic relegates the non-epistemic to religion. Because these possibilities remain largely untested, it is an open question whether and how scientific explanations might satisfy non-epistemic dimensions of existential curiosity, and indeed whether the non-religious turn to science (versus more humanistic alternatives) to do so.

Current Project

Across three studies, we ask whether scientific and religious explanations for the existential are differentially evaluated, and whether they are differentially offered. In Studies 1 and 2, we test different models of how domain and belief affect the attribution of epistemic and non-epistemic virtues to scientific and religious explanations for the existential. In Study 1, we operationalize belief through a measure of religiosity; in Study 2, we use a more fine-grained measure of belief in individual scientific or religious explanations. In Study 3, we turn from association to causation, testing the hypothesis that scientific and religious explanations are not only differentially *attributed* epistemic and non-epistemic virtues, but also differentially *generated* in response to epistemic aims (such as offering evidential support) vs. non-epistemic aims (such as offering emotional comfort). Study 3 also allows us to take a closer look at how the non-religious generate explanations in response to non-epistemic aims. As we elaborate in the General Discussion, our findings have implications for theories of scientific and religious cognition, including the conditions under which scientific and religious beliefs are likely to co-exist versus compete.

Study 1

In Study 1, we investigated the (perceived) epistemic and non-epistemic characteristics of religious and scientific explanations. Participants viewed a single religious or scientific explanation (see Table 1 for examples) for one of our three target questions: “How did the universe come to exist?”, “Why is there suffering in the world?”, or “What happens after we die?” They subsequently rated that explanation along a variety of dimensions designed to capture epistemic and non-epistemic characteristics (see Table 2 for items), and additionally indicated their own level of religiosity.

To measure epistemic characteristics, we included judgments related to evidential and logical support (Table 2, items 1-2), specification of a causal mechanism (Table 2, item 5), objective dimensions of knowledge (Table 2, items 6-7), and the role of authority and expertise (Table 2, items 3-4). To measure the non-epistemic characteristics of explanations, we included social considerations (Table 2, items 8-11, and 25), emotional considerations (Table 2, items 12-15, 23-24), self-concept/identity (Table 2, items 16-18), and moral considerations (Table 2, items 19-22).

This design allowed us to differentiate the three models depicted in Figure 1. On the assumption that our participant population would largely endorse scientific explanations, but show more variability in their endorsement of religious explanations, all three models predict that scientific explanations will, on average, be attributed more epistemic virtues than religious explanations. Models 1 and 2 (but not 3) additionally predict that religious explanations will, on average, be attributed more non-epistemic virtues than scientific explanations. However, on the assumption that religiosity tracks

endorsement of religious explanations, the three models diverge in their predictions of whether and how religiosity should moderate effects of domain. Model 1 predicts no moderation by religiosity. Models 2 and 3 both predict that greater religiosity should be associated with higher attributions of non-epistemic virtues to religious explanations, but only Model 3 predicts that greater religiosity should be associated with higher attributions of *epistemic* virtues to religious explanations as well.

To ensure that the explanations used as stimuli were representative of their respective domains (as conceived by our participants), we first assembled a stimulus set of explanations generated by an independent group of participants sampled from the same population. We then had yet another independent group sampled from the same population classify the explanations as scientific or religious. We describe this procedure below.

Method

All studies reported in this paper were approved by the Institutional Review Board at Princeton University. The predictions, sample size, exclusion criteria, and analysis plan for Study 1 were pre-registered, and are available at [<https://osf.io/5w3vf/>]. Departures from pre-registered analyses are noted.

Table 1. Sample scientific and religious explanations for the three existential questions used in Study 1.

Question	Scientific Explanation	Religious Explanation
“How did the universe come to exist?”	“By the big bang, a massive explosion that created all matter in the universe. This happened many billions of years ago.”	“The universe was created by God in 6 days. He created everything out of nothing by his own will. The last thing that he created was man, before he rested on the 7th day. Nothing came into existence by itself since you need life to create life.”
“Why is there suffering in the world?”	“Because not everyone has the same access to resources. Also because some areas are more developed than others. In addition there are many unfair things about living in areas without having the financial resources to better oneself.”	“Because there is free will in the world. God doesn't like suffering, but when man has free will there will be suffering.”
“What happens after we die?”	“After we die, our body ceases to function. We begin to decompose. We are generally buried or cremated.”	“Our spirit goes to heaven and we receive judgment for our deeds. some said our spirit travels all around the world and plays with angel.”

Participants

Participants were 501 adults (246 female, 249 male, 6 non-binary, $M_{Age} = 38$ years, $SD_{Age} = 11$ years) recruited on Amazon Mechanical Turk. Of these, 54% identified as Christian and 20% as Atheist, with the remaining 26% including other religious affiliations (e.g., Buddhist, Jewish, Hindu, Muslim) as well as “agnostic” and “spiritual.” Participation in all studies reported here and in the online supplement was restricted to workers in the United States who had not participated in related pilot studies or stimulus

generation, and who had an approval rating of at least 95%.¹ An additional 168 adults were excluded from analyses because they did not pass attention checks, detailed below.

Materials

Our materials included 10 religious and 10 scientific explanations generated in response to each of our three questions (“How did the universe come to exist?”, “Why is there suffering in the world?”, and “What happens after we die?”), for a total of 60 distinct explanations. Section I.II of the online supplement includes the complete set of explanations for each question. To obtain these explanations, we recruited an independent group of Amazon Mechanical Turk workers to generate answers in response to our existential questions. These answers were then presented to another independent group of Mechanical Turk workers, who classified the explanations as religious (“religious, supernatural, or spiritual”), scientific (“scientific, natural, or physical”), “both,” or “neither.” To be included in our final set of religious explanations, a given explanation had to be classified as religious by at least 75% of this second sample. Similarly, to be included in our final set of scientific explanations, a given explanation had to be classified as scientific by at least 75% of this second sample. Our pre-registered procedure for developing this stimulus set is described in detail in the online supplement (Section I.I).

Procedure

¹ For data collection from Mechanical Turk, the 95% approval rating was based on at least 500 prior tasks. For data collection from Prolific (in Study 2), this approval rating was based on 100 prior tasks.

Participants completed the study online using Qualtrics Survey Software (see OSF [<https://osf.io/n7bsv/>] for a link to the survey and a PDF file of the survey). They first received a short training on how to use the 5-point rating scale (with 1 indicating “strongly disagree” and 5 indicating “strongly agree”), and were instructed to select each of the five options once (e.g., “for this item, please select ‘Strongly agree’”). This training was used both to familiarize participants with the scale and as an exclusion criterion. Participants who did not respond to all five prompts correctly were excluded from analyses.

After this short training, participants were randomly assigned to one of six conditions based on the question (universe, suffering, death) and domain (science, religion), and they were randomly presented with one of the ten corresponding explanations. Each unique explanation from our stimulus set was seen and rated by 7-12 participants.

In the explanation rating task that followed, participants saw their assigned question at the top of the page (e.g., “What happens after we die?”) followed by their assigned explanation. They were asked to indicate their agreement with 25 statements about the explanation (see Table 2), presented in random order across five pages, using the 5-point scale introduced in training. Randomly intermingled among the 25 target statements were two attention check items that asked participants to “select the middle option” and to “select the second option from the right,” respectively. Participants who did not answer these questions correctly were excluded from analyses.

After completing the explanation rating task, participants completed a final set of judgments concerning the explanation's emotional role "for someone who believes it." There were six statements presented in a random order for which participants indicated agreement: For someone who believes it, this explanation "offers peace of mind," "is comforting," "is unsettling," "makes the world seem like an unpredictable place," and "provokes anxiety." In addition, participants saw a third attention check, which was randomly intermixed and prompted them to select the "first option from the left"; participant who provided incorrect responses to this item were excluded from analyses. We included these items to help interpret the responses of non-religious participants, and in particular, to disambiguate whether low ratings for religious explanations along non-epistemic dimensions (if observed) reflected lack of personal belief in the explanation, or a rejection of the connection between the explanation's content and non-epistemic characteristics.

Finally, participants were asked a number of demographic questions: gender, age, religious affiliation, and level of religiosity with four choices ("not religious at all", "slightly religious", "moderately religious", "very religious"), education level, income range, number of people in household, and state of residence. Participants were then debriefed and the study ended.

Results

Table 2. Explanation rating items from Study 1 clustered by factor, with corresponding factor loadings. Statements with asterisks were reverse-scored in composite scores.

Item (Measure)	Factor Loading	Factor
1. This explanation is based on evidence.	0.9	Evidential Support (Epistemic)
2. This explanation is based on logic.	0.8	
3. This explanation is based on facts that aren't supposed to be questioned.	0.8	
4. This explanation is based on expert knowledge.	0.6	
5. This explanation offers a clear cause-and-effect mechanism or pathway.	0.4	
6. We'll never know whether this explanation is right or wrong.*	0.6	Objectivity (Epistemic)
7. This explanation is right for some people, but it is not the right explanation for everyone.*	0.6	
8. Shared belief in this explanation can foster a feeling of personal connection.	0.6	Social Support (Non-epistemic)
9. People typically learn this explanation from others.	0.5	
10. Disagreeing about this explanation can threaten social bonds.	0.4	
11. This is the sort of explanation that brings people closer together.	0.4	
12. This explanation is unsettling.*	0.6	Emotional Comfort (Non-epistemic)
13. This explanation provokes anxiety.*	0.6	
14. This explanation offers peace of mind.	-0.5	
15. This explanation is comforting.	-0.5	
16. This explanation tells me something important about who I am.	0.8	Self & Identity (Non-epistemic)
17. This explanation helps me understand my true self.	0.8	
18. This explanation offers insight into my feelings and subjective experiences.	0.6	
19. If everyone believed this, the world would be a more moral place.	0.9	Moral World (Non-epistemic)
20. If everyone believed this, the world would be a kinder place.	0.9	
21. This explanation is harmful for the world.*	0.7	Accountability (Non-epistemic)
22. If everyone believed this, there would be no accountability for people's actions.*	0.6	
23. This explanation offers a sense of control.		Did not load on any factors
24. This explanation makes the world seem like an unpredictable place.		
25. Shared belief in this explanation enriches community values.		

Exploratory Factor Analysis and Composite Scores

For the 25 items included in the explanation rating task, we first conducted an exploratory factor analysis to identify associated factors in a bottom-up manner and to simplify subsequent analyses. We utilized the *GPArotation* (Bernaards & Jenrich, 2005) and *psych* packages in R (R Core Team, 2019). To select an optimal number of factors, we used the *fa* function from the *psych* package, specifying an oblique rotation and the minimum residual method. We modeled 5, 6, and 7-factor solutions. The 7-factor solution achieved simple structure and suggested good fit to the data, based on model parameters ($RMSR = 0.02$, $RMSEA = 0.04$, $Tucker\ Lewis\ Index = 0.96$, $p < 0.01$ compared to 6-factor model; see Table 2 for individual items loading on each factor). Prior to investigating the EFA patterns, and based on pre-registered criteria, we decided to keep factors with stable scores and to eliminate items with factor loadings less than 0.4 (see Guadagnoli & Velicer, 1988).

Among the seven factors that emerged, there were two interpretable epistemic factors (evidential support and objectivity) and five interpretable non-epistemic factors (social support, emotional comfort, self & identity, moral world, and accountability), with 22 of the initial 25 items loading onto a factor, and most items doing so as we would have expected. The most notable exceptions to our expectations were items 3 and 4, involving authority / expertise, which clustered with the evidence, logic, and causal mechanism items.

Based on the factors that emerged from this analysis, we created seven composite scores for further analyses. To do so, the items that loaded on each factor were averaged to create a single score between 1 and 5, with negative items reverse coded. Given that items 3 and 4 seemed conceptually distinct from the other “evidential support” items, we also analyzed all results using an “evidential support” factor that excluded these items, but the patterns of results mirrored those with the full set of items; we therefore proceed with the analysis including items 3 and 4.

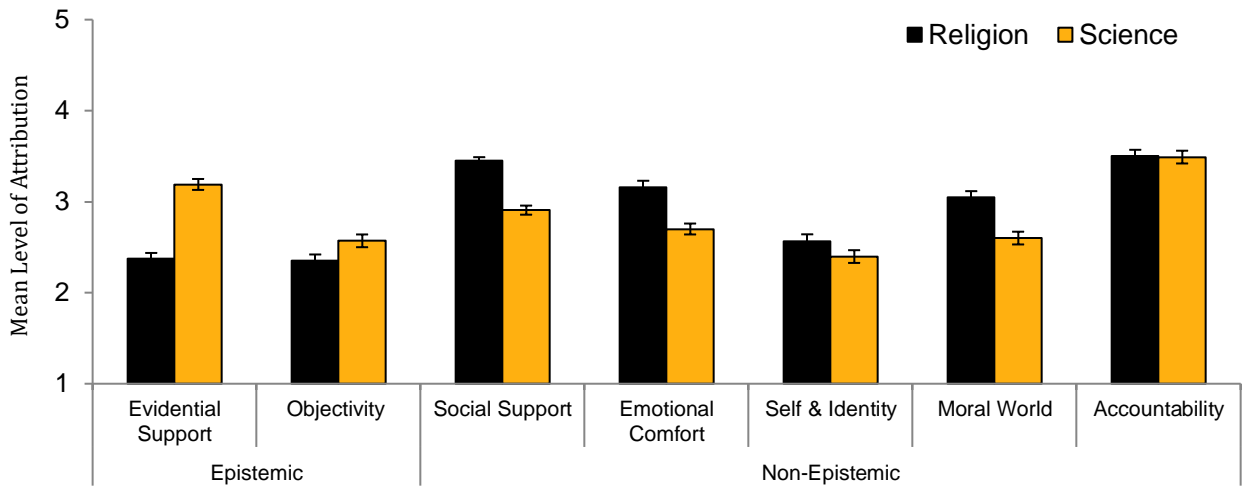


Figure 2. Mean composite score for each factor by Domain. Error bars indicate +/-1 SEM – Study 1.

Analytic Approach

To test for effects of domain, we conducted linear regressions with each of the seven composite scores as the dependent variable and Domain (Religion, Science) as a

predictor, using Religion as the reference category. Because we were additionally interested in moderating effects of religiosity, we also included individuals' level of religiosity and an interaction term (Domain x Religiosity). The Religiosity factor was treated as a centered linear variable. Finally, to control for possible effects of Question (Universe, Suffering, Death) and Question by Domain interactions, these terms were also included in the models, with contrasts defined to reflect deviation from the grand mean at each level of Question.²

Table 3 reports the parameters for the regression models of all seven composite scores. Figure 2 displays composite means as a function of domain; Figure 3 displays moderating effects of Religiosity for all composites. Additional analyses of significant interactions between Question and Domain, with corresponding figures, are reported in Supplementary Materials (Section I.IV.I and Figure S1). Below we summarize key results.

Epistemic Composites

For both epistemic composites (Evidential Support and Objectivity), we observed a main effect of domain, such that scientific explanations were on average judged to possess greater evidential support and to be more objective than religious explanations

² This is a slight deviation from our preregistered analysis scheme. We originally planned to run models stepwise, first including only Domain and Question and significant interactions between them, and then checking for moderating effects of Religiosity in a second model. Here, we decided to include all factors in the same model. We believe this is a more appropriate strategy because the role of Religiosity is central to the assumptions behind Models 1- 5, which we are testing (see Figures 1 and 4), and it should therefore be included in the analytic models at the outset. Notably, this departure from the pre-registered analysis does not have implications for any of the reported patterns of significance. See section I.IV.II of the supplementary materials for presentation of analyses as preregistered.

(see Figure 2). However, both of these effects were moderated by Religiosity (see Figure 3). For less religious participants, scientific explanations received higher ratings than religious explanations. For more religious participants, scientific and religious explanations did not differ significantly.

Table 3. Regression model results for each of the seven factors in Study 1. For Domain, “Religion” was always set as the reference category.

	Evidential Support (Epistemic)	Objectivity (Epistemic)	Social Support (Non-epistemic)	Emotional Comfort (Non-epistemic)	Self & Identity (Non-epistemic)	Moral World (Non-epistemic)	Accountability (Non-epistemic)
Intercept	2.41 (0.06)***	2.37 (0.07)***	3.47 (0.05)***	3.20 (0.07)***	2.62 (0.07)***	3.09(0.07)***	3.53 (0.07)***
Domain	0.76 (0.08)*** <i>CI [0.60, 0.92]</i>	0.21 (0.09)* <i>CI [0.60, 0.92]</i>	-0.55(0.09)*** <i>CI [-0.68, -0.42]</i>	-0.53 (0.10)*** <i>CI [-0.69, -0.36]</i>	-0.21(0.09)* <i>CI [-0.39, -0.03]</i>	-0.49 (0.10)*** <i>CI [-0.69, -0.29]</i>	-0.10 (0.10) <i>CI [-0.29, 0.10]</i>
Religiosity	0.51 (0.05)*** <i>CI [0.41, 0.61]</i>	0.31 (0.06)*** <i>CI [0.19, 0.42]</i>	0.16 (0.04)*** <i>CI [0.08, 0.25]</i>	0.29 (0.05)*** <i>CI [0.18, 0.39]</i>	0.72 (0.06)*** <i>CI [0.61, 0.84]</i>	0.55 (0.06)*** <i>CI [0.43, 0.68]</i>	0.13 (0.06)* <i>CI [0.01, 0.25]</i>
Domain X Religiosity	-0.59 (0.07)*** <i>CI [-0.73, -0.45]</i>	-0.26 (0.08)** <i>CI [-0.43, -0.10]</i>	-0.08 (0.06) <i>CI [-0.20, 0.04]</i>	-0.35 (0.08)*** <i>CI [-0.50, -0.20]</i>	-0.62 (0.08)*** <i>CI [-0.78, -0.46]</i>	-0.54 (0.09)*** <i>CI [-0.71, -0.36]</i>	-0.58 (0.09)*** <i>CI [-0.75, -0.40]</i>
Question (deviation from the grand mean)							
Death	-0.24 (0.08)**	-0.28 (0.09)**	0.08 (0.07)	0.19 (0.09)*	-0.11 (0.09)	0.02 (0.10)	0.27 (0.10)**
Suffering	0.17 (0.08)*	0.18 (0.09)	-0.15 (0.07)*	-0.47 (0.08)***	-0.03(0.09)	-0.09 (0.10)	-0.33 (0.17)***
Universe	0.07 (0.08)	0.10 (0.09)	0.08 (0.07)	0.28 (0.08)**	0.14 (0.09)	0.07 (0.10)	0.05 (0.10)
Domain X Question							

Death	0.23 (0.12)*	0.20 (0.13)	-0.22 (0.16)*	-0.58 (0.12)***	0.09 (0.13)	-0.20 (0.14)	-0.51(0.14)***
Suffering	-0.44 (0.11)***	-0.16 (0.13)	0.12 (0.16)	0.40 (0.12)***	0.03 (0.13)	0.23 (0.14)	0.19 (0.14)
Universe	0.21 (0.11)	-0.04 (0.13)	0.10 (0.09)	0.18 (0.12)	-0.13 (0.13)	-0.02 (0.14)	0.32 (0.14)*
<i>Adjusted R²</i>	0.30	0.07	0.16	0.20	0.24	0.16	0.13
<i>F</i>	32.09***	6.009***	14.51***	18.97***	23.21***	14.48***	11.28***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. For Question, we used deviation coding (sum. contrasts) to facilitate interpretation of main effects of Domain. This ensures that main effects of Domain do not represent marginal effects at a given level of Question, and rather represent effects of Domain at the average score for the DV across the three levels of Question.

Non-epistemic Composites

For all non-epistemic composites except for Accountability, we observed main effects of domain, such that religious explanations were on average judged to possess more non-epistemic virtues than scientific explanations (see Figure 2). However, ratings for all non-epistemic composites – with the exception of Social Support – additionally revealed a Domain by Religiosity interaction (see Figure 3). In all of these cases, greater religiosity was associated with higher attributions of non-epistemic virtues to religious explanations than to scientific explanations, while lower levels of religiosity involved an attenuation or reversal of this effect.

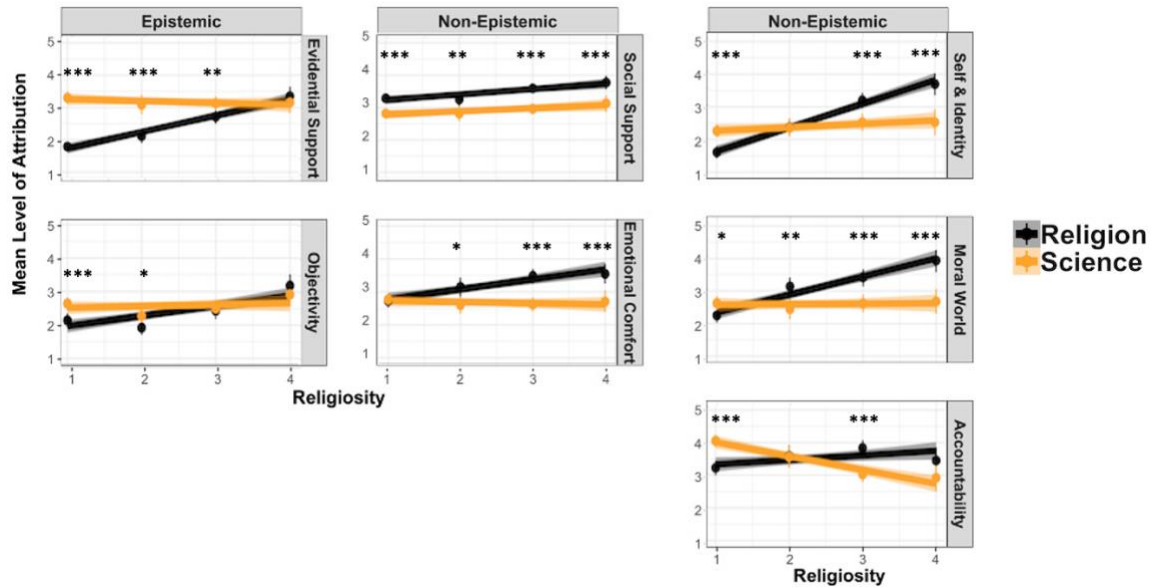


Figure 3. Moderating effects of participants' self-reported level of religiosity on explanation ratings for epistemic items (left column) and non-epistemic items (middle and right columns) as a function of explanation Domain (Religion, Science) for Study 1. Dots represent means at each level of Religiosity. Error bars represent 95% confidence intervals. The asterisks indicate significant effects of domain with simple slope analyses at each level of religiosity, with * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

Ratings of belief-based emotional considerations

Recall that in addition to the explanation ratings reported above, participants indicated how much they agreed or disagreed that the explanations would play emotional roles for a believer of that explanation. We created a single composite score for these items by averaging ratings (with negative items reverse scored), such that a higher number indicated stronger positive emotions and weaker negative emotions. Internal

consistency for the six items was high ($\alpha = 0.77$, 95% CI [0.73, 0.80]). To investigate the effect of Domain and Religiosity on this belief-based construct, we carried out the same regression analyses as above. Critically, the effect of Domain was significant ($B = -0.42$, $SE = 0.07$, $t = -6.20$, $p < 0.001$, 95% CI [-0.56, 0.29]), with higher ratings for religion than for science, but the interaction between Religiosity and Domain was not ($B = -0.07$, $SE = 0.06$, $t = -1.09$, $p = 0.28$, 95% CI [-0.18, 0.05]).³ These findings suggest that effects of Religiosity on attributions of emotional comfort to explanations for the existential were mostly driven by differences in endorsement of the proffered explanation, not by differences in what kinds of beliefs more or less religious participants expect to provide emotional comfort.

Discussion

The results of Study 1 revealed that our participants – all adults in the United States, and mostly Christian, if religious – attributed different characteristics to religious and scientific explanations for existential questions. Overall, scientific explanations were attributed more epistemic virtues (such as evidential support and objectivity), and religious explanations were attributed more non-epistemic virtues (such as moral and emotional benefits). However, these effects were moderated by level of religiosity. The greater attribution of epistemic virtues to scientific (vs. religious) explanations was driven by the non-religious; for the religious, both kinds of explanations were attributed

³ There was also a significant interaction between Question and Domain, $F(2, 492) = 10.21$, $p < 0.001$: For both Universe and Suffering, religious explanations were judged more positively; for Death, ratings did not vary by domain (see section I.IV and Figure S2 in online supplement).

moderate levels of evidential support and objectivity. By contrast, the greater attribution of non-epistemic virtues to religious (vs. scientific) explanations was driven by the religious; for the non-religious, neither kind of explanation was attributed much in the way of emotional, moral, or social value.

Notably, the observed patterns of domain- and belief-dependence challenge all three of the models with which we began. Challenging Model 1 (domain dependence, belief independence), we observed robust and largely consistent effects of religiosity. Challenging Model 2 (belief dependence, domain dependence), we observed that religiosity was associated not only with higher attributions of non-epistemic virtues to religious explanations, but with higher attributions of epistemic virtues as well. And challenging Model 3 (belief dependence, domain independence), we observed main effects of domain, such that religious explanations were attributed non-epistemic virtues at higher rates than were scientific explanations, even though we would expect higher levels of scientific (vs. religious) belief in our sample as a whole.

How might we reconcile these patterns of belief-dependence and domain-dependence? We propose two additional models that combine elements of Models 2 and 3, and that are consistent with the pattern of results from Study 1: belief dependence plus *weak* domain dependence and belief dependence plus *asymmetrical* domain dependence (see Models 4 and 5, respectively, in Figure 4). According to the former (Model 4), scientific and religious explanations are attributed both epistemic and non-epistemic virtues as a function of belief, but where the type of virtue additionally depends (weakly) on domain: for epistemic virtues, there is a stronger effect for scientific than for religious

explanations, and for non-epistemic virtues, there is a stronger effect for religious than for scientific explanations. According to the latter (Model 5), epistemic virtues are attributed as a function of belief in either domain, but non-epistemic virtues are only attributed to religious explanations. Study 2 provides a direct test of both models.

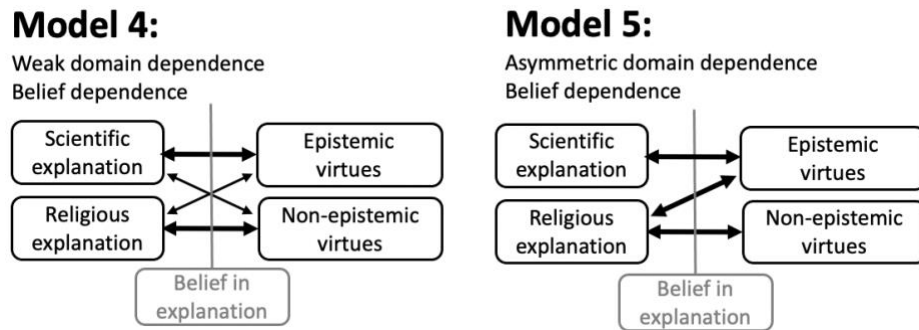


Figure 4. Two models, motivated by the findings from Study 1, each depicting a possible set of associations between the domain of an existential explanation and whether it is attributed epistemic and non-epistemic virtues. As in Models 2 and 3, Models 4 and 5 include a moderating role for belief, such that endorsement of a given explanation moderates the relationship between an explanation’s domain and the extent to which it is attributed epistemic or non-epistemic virtues.

Study 2

Study 2 was designed to test and differentiate between the models depicted in Figures 1 and 4. In Study 1, we used religiosity as a proxy for belief in the content of

religious explanations. In Study 2, we instead asked participants to indicate their endorsement of each explanation itself, offering a more direct test of belief. This is important for two reasons. First, with measures of belief not only for religious explanations but for scientific explanations as well, we are in a better position to differentiate our models, and to identify dissimilarities between science and religion, should any exist. Second, by measuring explanation endorsement independently of religiosity, we can potentially dissociate effects linked to endorsing a given religious explanation from more general individual differences associated with religiosity (such as a particular cognitive style, e.g., Pennycook et al., 2012; Shenhav, Rand, & Greene, 2012; but see Yonker et al., 2016).

To generate variability in endorsement of both scientific and religious explanations, and to increase the odds that religiosity and endorsement of religious explanations would be dissociable, Study 2 used experimenter-generated but pre-tested explanations selected to be more controversial. In each domain, we included two explanations for the origins of the universe, one more commonly endorsed by our target sample (i.e., the big bang for science, and a nonliteral interpretation of creation for religion), and the other less commonly endorsed by our target sample (i.e., the multiverse theory for science, and a literal interpretation of creation in six days for religion).

As in Study 1, participants rated explanations along epistemic and non-epistemic dimensions. However, our more fine-grained measure of explanation endorsement allowed us to test predictions of Models 4 and 5 that differentiate them from Models 1-3. Model 4 uniquely predicts that while explanation endorsement should be associated with

higher attributions of epistemic and non-epistemic virtues in both domains, the effect for epistemic virtues should be stronger for science than for religion, whereas the effect for non-epistemic virtues should be stronger for religion than for science. By contrast, Model 5 uniquely predicts that endorsement of religious explanations should be associated with the attribution of both epistemic and non-epistemic virtues, while endorsement of scientific explanations should only be associated with the former.

Method

The predictions, sample size, analyses, and exclusion criteria for Study 2 were pre-registered, and are available at [<https://osf.io/ef4yk/>].

Participants

Participants were 652 adults (322 identified as a woman, 316 as a man, 14 non-binary, $M_{\text{Age}} = 33$ years, $SD_{\text{Age}} = 12$ years) recruited on Prolific. Of these, 42% identified as Christian and 26% as Atheist, with the remaining 32% including other religious affiliations (e.g., Buddhist, Jewish, Hindu, Muslim) as well as “agnostic” and “spiritual.” An additional 28 adults were excluded from analyses because they did not pass attention checks, detailed below.

Procedure

Participants completed the study online using Qualtrics Survey Software (see OSF [<https://osf.io/57xmb/>] for a link to the survey and a PDF file of the survey). After a brief introduction to the task, participants were randomly assigned to see either religious or scientific explanations for the question about how the universe came to exist. All participants saw two explanations from the domain they were assigned to (in

counterbalanced order). Based on prior testing, the more prevalently endorsed religious explanation was: “The creation of the universe was set into motion by God billions of years ago. It was not necessarily created in 6 literal days.” The more prevalently endorsed scientific explanation was: “The universe began billions of years ago with the big bang: a single point with light and energy that expanded, eventually forming atoms, galaxies, and more.” The less prevalently endorsed religious explanation was: “The universe was created by God less than 10,000 years ago. He created the world in 6 days, and on the 7th day he rested.” The less prevalently endorsed scientific explanation was: “Our universe is in fact just one universe within parallel universes that make up the multiverse. Our own universe began with the big bang.” (Figure S3 in section II.I of the online supplement confirms our classification of these explanations as more or less prevalently endorsed within each domain.)

For each explanation, participants first reported their personal endorsement (“I believe this explanation is true”), on a scale from 1-5, with 1 representing “strongly disagree” and 5 representing “strongly agree.” Using the same scale, participants then rated the explanation on five epistemic and five non-epistemic items, presented in random order. The five epistemic items included all of the items that loaded on the Evidential Support factor in Study 1 (evidence, logic, authority, expert, cause-and-effect; see items 1-5 in Table 2). We opted to include only the evidential support items because the pattern of moderation for religiosity in Study 1 was more pronounced for Evidential Support than for Objectivity. We selected the five non-epistemic items from three of the factors in Study 1 that showed clear patterns of moderation: emotional comfort (anxiety,

peace of mind, and comfort; items 13, 14, and 15 on Table 2), self & identity (identity, item 16 on Table 2), and accountability (harm, item 21 on Table 2). Lastly, as part of a general demographics questionnaire, participants reported their level of religiosity on the same measure included in Study 1, as well as scientific outlook (“to what extent do you consider yourself to have a scientific worldview?”) on a multiple-choice question with four choices (“not at all”, “slightly so”, “moderately so”, “very much”).

Results

Analytic Approach

We first created two composite scores, Epistemic and Non-epistemic. Negatively phrased items (i.e., Anxiety and Harm) were reverse-coded before creating the composites, so higher numbers always corresponded to the positive pole of each dimension (e.g., more evidence, less anxiety, etc.). Reliability was acceptable for both dimensions ($\alpha = 0.84$, 95% $CI [0.83, 0.86]$, and $\alpha = 0.76$, $CI [0.74, 0.78]$, for epistemic and non-epistemic, respectively). We then ran mixed-effects linear regression models, using the *lme* function from the *nlme* package in *R*, separately on each composite (Epistemic, Non-epistemic), with Domain, Endorsement, and the interaction term as fixed-effects, defining a random intercept to account for within-participant variability across Explanation Type (more prevalent, less prevalent).⁴ The Endorsement factor was

⁴ To complement the analysis of each of the epistemic and non-epistemic composites separately, we also ran another mixed-effects regression model, including a three-way interaction between Domain, Endorsement, and Dimension (epistemic, non-epistemic), with Dimension as a within-subjects random effect varying within each level of Explanation Type. This model confirmed a significant three-way interaction between Domain, Endorsement, and Dimension ($B = -0.18$, $SE = 0.03$, $t = -5.68$, $p < 0.001$), which corroborates the results we report from the separate models on the epistemic and non-epistemic composites.

centered. These analyses were then repeated with Religiosity and Scientific Worldview as additional factors (both centered), to help isolate effects specific to Endorsement from more general individual differences.

Effects of Domain and Endorsement

For the attribution of Epistemic virtues, there was a significant effect of Domain ($B = 0.47, SE = 0.05, t = 10.02, p < 0.001, 95\% CI [0.38, 0.47]$; see Figure 5) and a significant effect of Endorsement ($B = 0.45, SE = 0.02, t = 25.54, p < 0.001, 95\% CI [0.42, 0.49]$), as well as the predicted interaction between these two factors ($B = 0.11, SE = 0.03, t = 4.11, p < 0.001, 95\% CI [0.06, 0.16]$) (see Figure 6).

To follow up the interaction, we investigated the effect of Endorsement within each domain. There were significant effects of Endorsement within Religion ($B = 0.44, SE = 0.02, t = 26.04, p < 0.001, 95\% CI [0.41, 0.48]$) and also within Science ($B = 0.55, SE = 0.02, t = 27.10, p < 0.001, 95\% CI [0.51, 0.59]$), such that more strongly endorsing an explanation was associated with higher ratings of epistemic virtues to that explanation (stronger evidence, more logical, etc.), whether the explanation was religious or scientific. However, level of endorsement was *more strongly* associated with the attribution of epistemic virtues for scientific explanations than for religious explanations (see Figure 6).⁵

⁵ For religious explanations, when we additionally controlled for possible effects of Explanation Type and Order, there were no effects of either ($B = 0.00, SE = 0.04, t = 0.09, p = 0.92$ and $B = 0.00, SE = -0.05, t = 0.06, p = 0.44$, respectively), and the effect of Endorsement remained significant ($B = 0.44, SE = 0.02, t = 25.10, p < 0.001$). For scientific explanations, there was a main effect of Explanation Type ($B = 0.42, SE = 0.04, t = 9.52, p < 0.001, 95\% CI [0.33, 0.51]$), but no effect of Order ($B = -0.09, SE = 0.06, t = -1.47, p = 0.14$), and the effect of Domain

For the attribution of Non-epistemic virtues, there was again a main effect of Domain ($B = -0.45, SE = 0.04, t = -9.78, p < 0.001, 95\% CI [-0.54, -0.36]$), as well as a main effect of Endorsement ($B = 0.50, SE = 0.02, t = 30.47, p < 0.001, 95\% CI [0.46, -0.53]$) and the predicted interaction ($B = -0.11, SE = 0.02, t = -4.11, p < 0.001, 95\% CI [-0.16, -0.06]$).

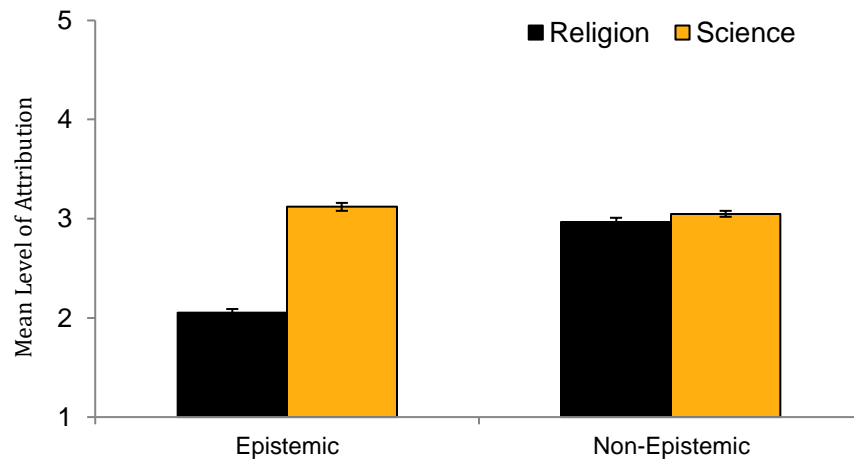


Figure 5. Average levels of attribution of epistemic and non-epistemic virtues to religious and scientific explanations in Study 2. Error bars represent +/- SEM.⁶

remained significant ($B = 0.47, SE = 0.02, t = 22.30, p < 0.001$). To ensure that the main effect of Explanation Type in the case of scientific explanation does not explain the pattern of interaction between Domain and Endorsement in the attribution of epistemic virtues, we repeated the main model (on the Epistemic composite) with all of the previous specifications, but this time controlling for Explanation Type. The interaction between Domain and Endorsement remained significant in this model ($B = 0.16, SE = 0.03, t = 5.46, p < 0.001, 95\% CI [0.10, 0.22]$).

⁶ When level of explanation endorsement is considered, an effect of domain on the attribution of non-epistemic virtues additionally emerges (see Figure 6). When averaging across the whole sample, as plotted here, this effect is obscured by the fact that low levels of endorsement were more common for Religion, and high levels of endorsement were more common for Science.

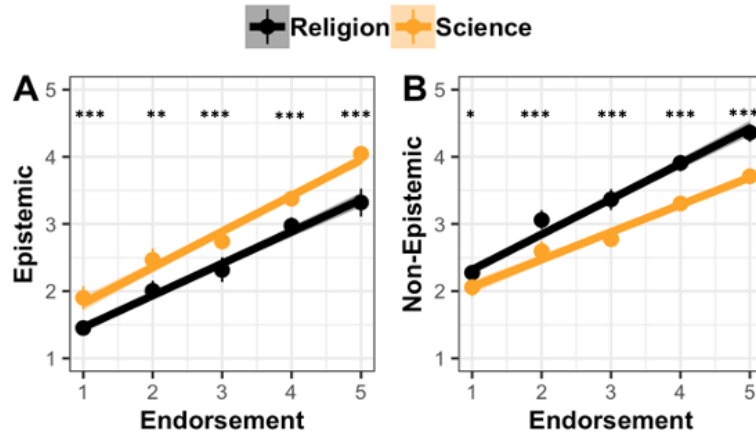


Figure 6. For Study 2, moderating effects of explanation endorsement on the attribution of epistemic (panel A) and non-epistemic (panel B) virtues to that explanation in each Domain (Religion, Science). Dots represent means at each level of Endorsement. Error bars represent 95% confidence intervals. The asterisks indicate significant effects of domain with simple slope analyses at each level of endorsement, with * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

Follow-up models within each domain revealed a main effect of Endorsement on non-epistemic attributions for both Religion ($B = 0.49$, $SE = 0.02$, $t = 28.84$, $p < 0.00$, 95% CI [0.46, 0.53]) and for Science ($B = 0.39$, $SE = 0.02$, $t = 22.52$, $p < 0.001$, 95% CI [0.36, 0.42]), such that more strongly endorsing an explanation was associated with higher attributions of non-epistemic virtues to that explanation (emotional comfort, moral benefits, etc.), whether that explanation was religious or scientific. However, level of

endorsement was *more strongly* associated with the attribution of non-epistemic virtues for religious explanations than for scientific explanations.⁷

Individual differences

The moderating effects of Endorsement could have been driven specifically by belief in the target explanation, or more generally by a religious or scientific worldview and its associated characteristics. To see whether the moderating effects of Endorsement uniquely contribute to patterns of attribution of epistemic and non-epistemic virtues above and beyond possible moderating effects of Religiosity and Scientific Worldview, we repeated our key analyses with the interaction term between Domain and Religiosity as well as between Domain and Scientific Worldview as additional factors. For both Epistemic and Non-epistemic virtues, the interaction between Domain and Endorsement remained significant ($B = 0.17$, $SE = 0.03$, $t = 5.86$, $p < 0.001$, 95% $CI [0.11, 0.17]$ and $B = -0.08$, $SE = 0.03$, $t = -2.99$, $p = 0.003$, 95% $CI [-0.13, -0.03]$, respectively).

To ask if results from Study 1 replicate in Study 2, we also ran an additional model with the Religiosity X Domain interaction. The moderating effect of Religiosity on Domain for both Epistemic and Non-epistemic ratings was consistent with the results from Study 1 (see section II.II and Figure S4 in the online supplement).⁸

⁷ There were no effects of Explanation Type or Order on the attribution of Non-epistemic virtues to religious or scientific explanations when we added these to the models, and the effect of Endorsement remained significant for the attribution of both kinds of virtues.

⁸ Additionally, we asked how Scientific Outlook might moderate the effect of Domain for Epistemic and Non-epistemic ratings. See section II.II and Figure S5 in the online supplement. Scientific Outlook moderates ratings in a pattern opposite to that observed for Religiosity.

Discussion

The findings from Study 2 reveal that endorsing the truth of a religious explanation is associated with judging that explanation to possess non-epistemic virtues (consistent with Models 2-5) as well as epistemic virtues (consistent with Models 3-5). They also reveal that endorsing the truth of a scientific explanation is associated with judging that explanation to possess epistemic virtues (consistent with Models 2-5) as well as non-epistemic virtues (consistent with Models 3-4). Finally, they reveal that the *strength* of the association between endorsement and virtue type (epistemic vs. non-epistemic) depends on the explanation's domain. In particular, endorsement is more strongly associated with epistemic attributions for science than for religion, and endorsement is more strongly associated with non-epistemic attributions for religion than for science (consistent only with Model 4). Moreover, these effects are specific to endorsement of an explanation's truth, and not simply an artifact of a scientific worldview or religiosity. Thus, across Studies 1-2, we have unique support for Model 4.

Study 3

Studies 1 and 2 provide compelling evidence that endorsed explanations for the existential – whether scientific or religious – are attributed both epistemic and non-epistemic virtues, with a stronger association between science and the epistemic, and between religion and the non-epistemic (supporting Model 4). Study 3 goes beyond these correlational results in two ways.

First, Study 3 tests for a *causal* relationship between explanatory aims and the domain of a generated explanation. Given the differing strengths of association between

explanatory virtues and domain in Model 4, is it the case that epistemic explanatory goals (e.g., aiming for evidential and logical support) prompt more scientific explanations, and that non-epistemic explanatory goals (e.g., aiming for emotional comfort) prompt more religious explanations? This result would also be consistent with Models 1 and 2, but not Model 3 (which would not predict any systematic effects of explanatory goals on domain) nor Model 5 (which would predict an increase in religious explanations given non-epistemic explanatory goals, but no systematic effects of domain given epistemic explanatory goals).

Second, Study 3 allows us to ask *how* the non-religious satisfy non-epistemic needs, such as emotional comfort and peace of mind, in response to existential queries. As reviewed in the introduction, prior work has suggested that under some conditions, scientific explanations can satisfy existential anxiety and a need for control, much like religious explanations (e.g., Tracy, Hart, & Martens, 2011; Farias et al., 2013). However, it remains unclear whether the non-religious typically satisfy non-epistemic needs by appeal to science, or in other (secular) forms. For example, an explanation for what happens after death could appeal to the memories or societal contributions that an individual leaves behind, plausibly offering a source of comfort but without explicit appeal to religion *or* to science. With the design of Study 3, we can ask: are the non-religious explanations offered in response to non-epistemic goals systematically different from those generated to meet epistemic goals? And insofar as they offer sources of existential comfort, does that comfort come in scientific form?

Participants were asked to answer one of the three existential questions from Study 1 while focusing either on epistemic characteristics (e.g., evidence, logic, causal pathways) or non-epistemic characteristics (e.g., peace of mind, emotional comfort). As a baseline, we also included a third condition that did not prompt either epistemic or non-epistemic characteristics. We predicted that focusing on epistemic characteristics would encourage participants to generate explanations that were more scientific and less religious (compared to baseline), while focusing on non-epistemic characteristics would encourage participants to generate explanations that were more religious and less scientific (compared to baseline). Because participants generated their own explanations in Study 3 (unlike Studies 1-2, in which an explanation was presented), we assumed that participants would all endorse their own explanations, and hence we did not pursue questions regarding a moderating role for belief.

Method

The predictions, sample size, exclusion criteria, and analyses for Study 3 were pre-registered, and are available at [<https://osf.io/vwmu8/>].

Participants

Participants were 494 adults (241 female, 249 male, 4 non-binary, $M_{\text{Age}} = 39$ years, $SD_{\text{Age}} = 13$ years) recruited as in Study 1. Of these, 51% identified as “Christian” and 19% as “Atheist,” with the remaining 30% including other religious affiliations (Hindu, Jewish, Muslim, Buddhist) as well as “Spiritual” and “Agnostic.” Participation was restricted to workers who had not previously participated in Study 1 or 2, or in any of the related pilot studies (including studies reported in the online supplement under

Stimulus Generation for Study 1 – Section I.I). An additional 47 adults participated but were excluded from analyses because they did not pass attention checks, described below.

Procedure

Participants completed all study procedures on a Qualtrics survey (see OSF [<https://osf.io/3xmj9/>] for a link to the survey and a PDF file of the survey). Each participant pledged to pay attention and answer questions carefully by writing that they would do so in a text box. Participants who typed irrelevant words into this text box (e.g., “statement”, “good”) were excluded from analyses. (The decision to exclude these participants was made for this study specifically because following instructions for a written response was the main task.) Participants were randomly assigned to one of three existential questions (“How did the universe come to exist?”, “Why is there suffering in the world?”, or “What happens after we die?”), and to one of three focus conditions (Non-epistemic, Control, Epistemic). In all three conditions, participants were encouraged to answer their designated question by focusing on specific explanatory goals.

In the Non-epistemic focus condition, participants were presented with the following instruction: “We’d like you to provide the best explanation that you can, focusing on an answer that OFFERS PEACE OF MIND, that is COMFORTING, and that REDUCES ANXIETY. We realize that this may be a challenge - just do your best!” In the Control condition, the instructions encouraged participants to focus on an answer “that is CLEAR and GRAMMATICAL.” In the Epistemic focus condition, they were

encouraged to focus on an answer “that is based on EVIDENCE, that is LOGICAL, and that offers a clear CAUSE-AND-EFFECT MECHANISM or pathway.”

All participants were invited to write their explanation into an essay box with a minimum of 120 characters and with no upper limit. The time it took participants to write their explanation and click the “next” button was recorded. Participants were excluded if this time was less than 40 seconds, or if they provided responses that were irrelevant to the instructions (e.g., “it’s a good and easy survey of the survey and then using to the research center...”) or that were copied directly from the instructions or from sources on the internet (e.g., “Universe is assembled into light atoms like hydrogen and helium; these atoms clumped first into galaxies”).

After typing in their explanation, all participants were directed to a second page with the explanation they provided reproduced at the top. This was followed by the question, “To what extent would you say that the explanation you provided has the following characteristics?” The question was followed by 15 items, appearing in random order, next to a scale of 1-7 with 1 indicating “Not at all” and 7 indicating “Very much.” Two of these items were the main variables of interest, one measuring the extent to which participants believed the explanation they provided “belongs to the domain of science” and the other measuring the extent to which they believed it “belongs to the domain of religion.” An additional item asked whether the explanation “has spiritual implications,” and was included as an additional measure in case participants construed the religion item too narrowly (e.g., as excluding supernatural beliefs outside of institutionalized religion).

The remaining twelve items were based on the findings from Study 1 and fell into one of four groups: epistemic or non-epistemic crossed with “instructed” versus “generalized.” Instructed items were those that probed the dimensions directly targeted by a focus condition and served as a manipulation check. There were two instructed epistemic items (“is logical,” “is based on evidence”) and two instructed non-epistemic items (“has positive emotional implications,” “has negative emotional implications,” with the latter reverse-coded). We included additional epistemic and non-epistemic items to see whether effects of focus condition extended beyond the characteristics that were explicitly instructed (e.g., “is verifiable,” “has positive social implications”).

On the next page, participants were asked how confident they were that the explanation they provided is true, on a scale of 1-7 with 1 indicating “Not confident at all” and 7 indicating “Very confident.” Results from this measure are presented in the online supplement (section III.I.I).

Finally, participants were asked to answer a number of demographic questions, including questions about gender, age, religious affiliation, and level of religiosity with four choices (not religious at all, slightly religious, moderately religious, very religious), followed by education, income, number of people in the household, and state of residence. On the last page, participants were debriefed and the survey ended.

Explanation coding⁹

⁹ This coding was conducted for exploratory purposes. The coding categories were not determined prior to the experiment, nor were the associated analyses pre-registered.

In addition to the explanation ratings provided by participants, all explanations were coded by two independent coders, with disagreements resolved by a third coder. For all coders, focus condition was masked, but the question being answered was not. The coding categories are described below.

First, participants' explanations were coded for the inclusion of religious and/or scientific content. To identify religious content, we considered three categories of response: "religious," which required the inclusion and endorsement of explicitly religious entities or processes, such as God, a soul, or Heaven ("After we die, depending on how we lived we go to either Heaven or Hell for eternity. Our physical body dies but our soul, our spirit lives on forever."), "spiritual," which appealed to supernatural elements or ideas (e.g., spirit, force) but without including more traditional / explicitly religious terms ("I think our body even though you can't feel, it just goes in a state of permanent hibernation and a person can still sense things around him or her, like fresh flowers or fresh cut grass; just something blissful"), and "none," which included neither religious nor spiritual references. To identify scientific content, we considered three categories of response: natural/physical scientific, which endorsed natural or physical scientific terms or processes (e.g., "The Big Bang, explained through quantum physics, i.e., atoms coming into existence from nothing. Then that expands and here we are today I guess."), social scientific content, which included reference to psychological, social, economic, and/or structural processes ("There is suffering in the world because the economic system is designed and operates in such a way that some selected few controls the wealth...and this wealthy few will rather seek to get cheap labor and offer crumbs to

the populace.”), and “none,” which included neither natural/physical nor social scientific content. Coder agreement for both coding categories was substantial ($Kappa = 0.72, p < 0.001$, for both religious and scientific content).

To better understand how both religious and non-religious participants tailored their explanations to meet non-epistemic goals, explanations were also coded for the inclusion of religious/supernatural or naturalistic sources of comfort. Examples of religious/supernatural comfort included allusions to eternal life and being united with loved ones (“...a place where our souls can go to finally rest and be with the souls of departed loved ones...”), having a special place in the universe (“...rest assured that you have a special place in God’s universe and everything is unfolding exactly as planned”), and redemption from suffering (“...because sin exists...[Jesus Christ] came to abolish sin, and through faith in Him, we can be forgiven of our sins...”). Examples of naturalistic comfort included allusions to being remembered after death (“our memory remains in the hearts and minds of those who loved us and those we left behind.”), being awe-struck by the magnificence of the natural world (“...stars have grown and life started, as someone else said, ‘we are the universe experiencing itself’, which is beautiful and should be treasured.”), and reassuring statements about the positive side of suffering (“usually suffering is what builds the bridge of choice to a better future”). In a few cases, participants indicated that a certain *belief* provides comfort (“Believing in God and some form of life after death seems to me to offer the most hopeful outcome for all of us.”); these were coded as “belief comfort.” Coder agreement was substantial ($Kappa = 0.68, p < 0.001$).

Results

Manipulation Check

First, we note that the experimental manipulation was effective in the sense that participants in the non-epistemic focus condition (vs. control) more strongly agreed that their explanations included the instructed non-epistemic features, and participants in the epistemic condition (vs. control) more strongly agreed that their explanations included the instructed epistemic features. Interestingly, these effects extended to the generalized features of each type, and the two focus conditions suppressed alternative characteristics (e.g., in the non-epistemic focus condition, epistemic features were suppressed, relative to control). The full results for these measures are reported in the online supplement (section III.I.I).¹⁰

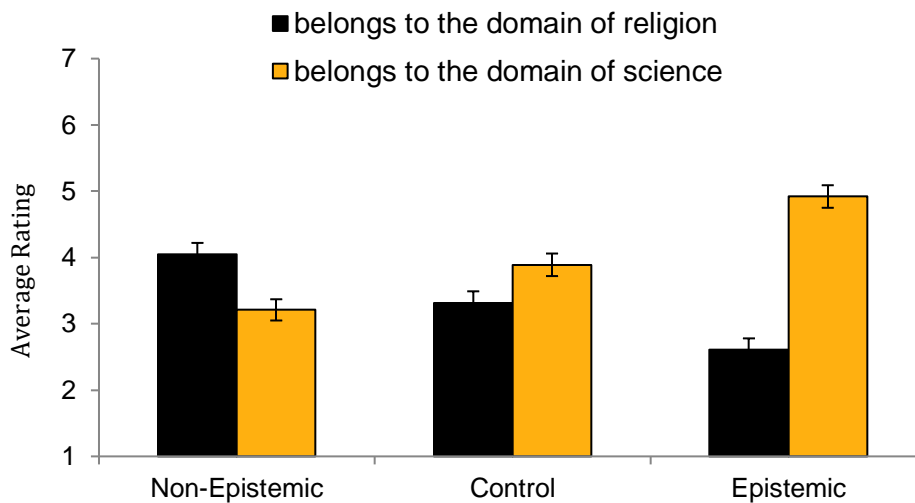
Analytic approach

We investigated the effect of focus Condition (Non-epistemic, Control, Epistemic) on religion/science ratings (“belongs to the domain of religion”, “belongs to the domain of science”) with two linear regressions using the *lm* function in R, and with Condition as a categorical predictor and using Control as the reference category (see

¹⁰ We also ran an additional preregistered study in which we invited an independent group of participants to rate the explanations generated by participants in Study 3. We did so to verify that the experimental manipulation affected the content of explanations, such that the manipulation check questions were not simply a response to task demands. In this study, we replicated the trends reported here.

Figure 7). Religion/science ratings were considered in separate models.¹¹ Notably, for these analyses, patterns were consistent across the three Questions (see Figure S9 in the Supplementary Materials for the same data as a function of Question). We also tested for moderating effects of religiosity, subsequently adding a Religiosity term and a Religiosity x Condition interaction; these patterns are presented in the online supplement (Section III.IV).

Effects of Condition on Participants' Domain Ratings



¹¹ To complement the analysis of each of the “religious” and “scientific” ratings separately, we also ran a mixed-effects regression model, including the interaction between Domain (religious and scientific) and Condition, with Domain as a within-subjects random effect varying within each participant. This model confirmed a significant interaction between Domain and Condition both when the control condition is compared to the Epistemic condition ($B = 1.74, SE = 0.34, t = 5.09, p < 0.001$), and when the control condition is compared to the Non-epistemic condition ($B = -1.42, SE = 0.33, t = -4.25, p < 0.001$). This pattern of interaction corroborates the results we report from the separate models on the scientific and religious ratings separately.

Figure 7. In Study 3, participants' average ratings of "belongs to the domain of religion" and "belongs to the domain of science" for generated explanations in each Condition.

Error bars indicate +/-1 SEM.

For religion ratings, there was a main effect of Condition (Control vs. Non-epistemic: $B = 0.74$, $SE = 0.24$, $t = 3.04$, $p = 0.002$, 95% $CI [0.26, 1.22]$; Control vs. Epistemic: $B = -0.70$, $SE = 0.25$, $t = -2.82$, $p = 0.005$, 95% $CI [-1.19, -0.21]$).

Explanations in the Non-epistemic condition were classified as more religious than Control, and explanations in the Epistemic condition were classified as less religious than Control. In addition, explanations in the Epistemic condition were classified as less religious than those in the Non-epistemic condition ($B = -1.44$, $SE = 0.25$, $t = -5.82$, $p < 0.001$). Ratings for "has spiritual implication" mirrored these effects of Domain, although there was also an interaction between Question and Condition (see section III.I.II of the online supplement).

Science ratings similarly revealed the predicted effect of Condition (Control vs. Non-epistemic: $B = -0.68$, $SE = 0.23$, $t = -2.89$, $p = 0.004$, 95% $CI [-1.13, -0.22]$; Control vs. Epistemic: $B = 1.04$, $SE = 0.24$, $t = 4.33$, $p < 0.001$, 95% $CI [0.57, 1.51]$).

Explanations in the Non-epistemic condition were classified as less scientific than Control, and explanations in the Epistemic condition were classified as more scientific than Control. In addition, explanations in the Epistemic condition were classified as less religious than those in the Non-epistemic condition ($B = -1.44$, $SE = 0.25$, $t = -5.82$, $p < 0.001$).

These effects of condition on the domain of generated explanations were replicated when we analyzed explanation coding categories, rather than relying on participants' own ratings (see Figure 8A and 8B; also see corresponding analysis in section III.I.V of the online supplement).

Relationship between Condition and Comfort Coding

To investigate how sources of comfort were offered (especially in the Non-epistemic condition), we fit two logistic regressions on experimenter codes for comfort: one predicting religious comfort (1 for religious/supernatural comfort, 0 otherwise) and one predicting naturalistic comfort (1 for natural comfort, 0 otherwise), in both cases as a function of Condition.

For religious/supernatural comfort, there was a main effect of Condition, with explanations featuring elements of religious/supernatural comfort generated more often in the Non-epistemic condition and less often in the Epistemic condition, compared to Control ($B = 1.86$, $SE = 0.34$, $z = 5.47$, $p < 0.001$, $CI [1.23, 2.58]$, $OR = 6.46$ and $B = -1.78$, $SE = 0.25$, $z = -2.18$, $p = 0.03$, $CI [-1.04, -0.06]$, $OR = 0.17$, respectively; see Figure 8C). (In exploratory models including Question, these trends held for all questions; see Figure S12 in the online supplement). Subsequently including Religiosity in the model showed a main effect of Religiosity ($B = 0.86$, $SE = 0.16$, $z = 5.28$, $p < 0.001$), such that more religious participants were more likely to generate explanations with elements of religious/supernatural comfort.

For natural comfort, the model similarly revealed a main effect of Condition, with explanations featuring elements of natural comfort more often generated in the Non-

epistemic condition and less often generated in the Epistemic condition, compared to control ($B = 1.32$, $SE = 0.32$, $z = 4.10$, $p < 0.001$, $CI [0.71, 1.97]$, $OR = 3.73$ and $B = -1.09$, $SE = 0.53$, $z = -2.06$, $p = 0.04$, $CI [-2.23, -0.12]$, $OR = 0.33$, respectively; see Figure 8C). (In exploratory models including Question, there was a significant interaction between Question and Condition, as well as a main effect of Question ($X^2 = 14.98$, $p = 0.005$), with the effects of Condition consistent between the Death and Suffering questions, but more variable for the Universe question; see Figure S12 in the online supplement.) Controlling for the interaction with Question, the main effect of Condition remained significant with the predicted pattern, and with a main effect of Religiosity ($B = -0.57$, $SE = 0.16$, $z = -3.6$, $p < 0.001$), such that more religious participants were *less* likely to generate explanations featuring elements of natural comfort.

In the Non-epistemic condition, religious/supernatural sources of comfort were offered more often than natural sources of comfort (57 vs. 46 explanations out of 171), but this numerical difference was not significant ($X^2 = 1.49$, $p = 0.23$), and cannot fully explain why religious explanations were more prevalent than scientific explanations in the Non-epistemic condition. Instead, the explanation partially lies in the fact that only a modest proportion of explanations that contained natural sources of comfort were classified as containing scientific content (17 of 46, or 37%), whereas virtually all explanations that contained spiritual/religious comfort were classified as spiritual or

religious (56 out of 57, or 98%).¹² So while many participants generated natural sources of comfort, they often did so without any explicit appeal to scientific entities or processes.

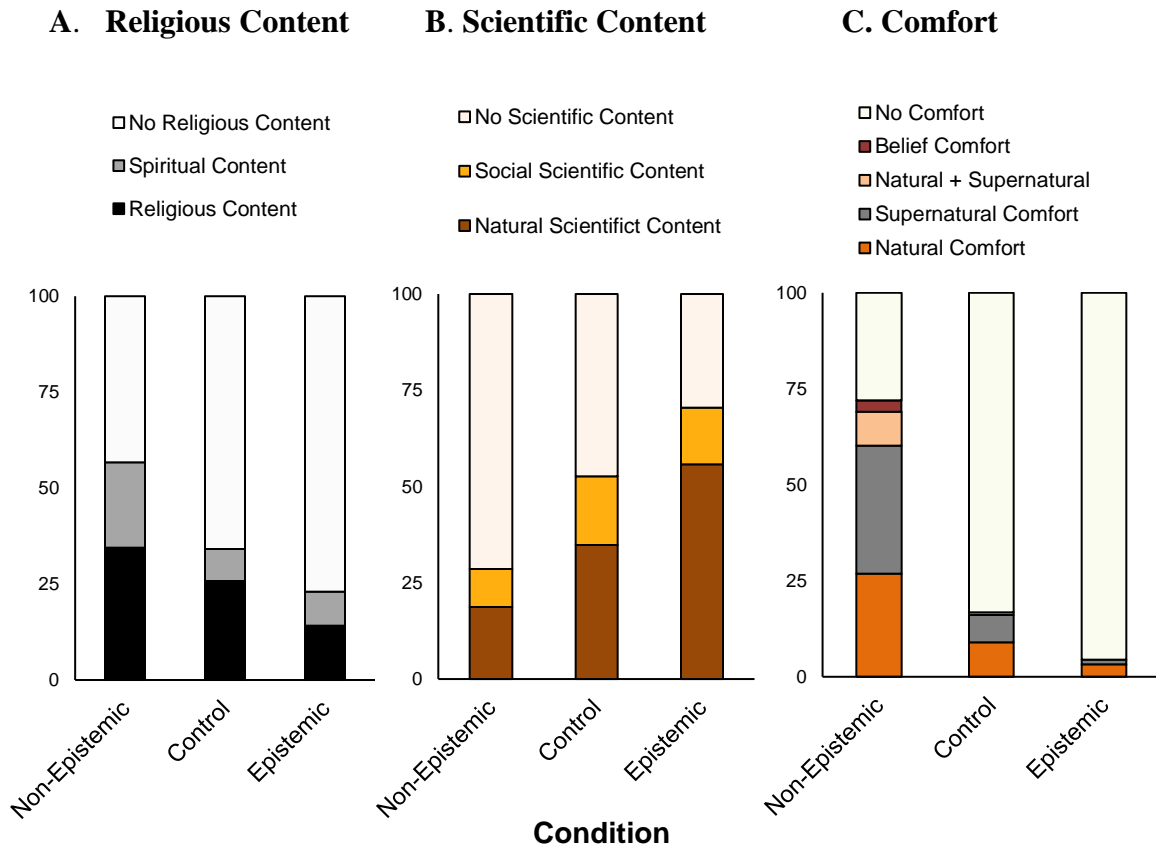


Figure 8. In Study 3, percentages of explanations with each coded category of (A) religious content and (B) scientific content, and comfort (C) as a function of condition.

¹² The single explanation that was coded as containing religious/supernatural comfort, but that was not classified as religious/supernatural, read as follows: “I don't think anybody knows what the answer to that question is. Some people talk about a white light or seeing someone they know but I think those are just repressed memories. I like to think we will see the people that we used to know and the Animals we used to know.”

Discussion

In Study 3, we adopted an experimental approach, manipulating explanatory goals and assessing effects on the domain of explanation provided, as well as the explanation's non-epistemic characteristics (i.e., sources of comfort). Most importantly, we found that our manipulation of explanatory goals affected the domain of the proffered explanation: relative to control, epistemic instructions made scientific explanations more prevalent and religious explanations less prevalent, with non-epistemic instructions generating the opposite pattern of results. These patterns were observed whether we relied on participants' own domain classifications or on those of independent coders. These findings suggest that explanatory goals have a causal effect on the characteristics and domain of explanations for existential questions. They also challenge Model 3 (given that both types of explanatory goals shifted domain) and Model 5 (given that epistemic explanatory goals shifted domain), leaving Model 4 as the only model consistent with the results of Studies 1-3.

The results of Study 3 also shed light on how people meet non-epistemic explanatory demands. While some participants appealed to religious sources of comfort (such as the idea that we will be united with our loved ones in heaven), others successfully generated sources of "naturalistic" comfort (such as the idea that we live on through the memories of those we love), even though such appeals were rarely classified as explicitly scientific.

General Discussion

Science and religion both offer answers to existential questions, such as what happens after we die, or how the universe came to exist. Explanations from each domain clearly differ in content, but do they also differ in their psychological roles? Across three studies, we investigated the epistemic and non-epistemic characteristics of scientific and religious answers to existential questions, revealing variation across domains and as a function of belief.

In Study 1, we found that on average, US adults attribute more epistemic virtues (e.g., evidence, objectivity) to scientific explanations than to religious explanations, and more non-epistemic virtues (e.g., social, emotional, and moral value) to religious explanations than to scientific explanations. However, these effects were moderated by religiosity. Religious participants attributed both epistemic and non-epistemic virtues to religious explanations. Non-religious participants, on the other hand, only attributed epistemic virtues to scientific explanations, and did not attribute non-epistemic virtues to explanations from either domain.

In Study 2, we used a more fine-grained measure of belief and found that more strongly endorsed explanations – whether religious or scientific – were more frequently attributed both epistemic and non-epistemic virtues. However, the magnitudes of these effects varied across domains. Endorsing an explanation was more strongly associated with the attribution of epistemic virtues for science (vs. religion), but more strongly associated with the attribution of non-epistemic virtues for religion (vs. science).

In Study 3, we investigated the psychological roles of religious and scientific explanations more directly. Using an experimental manipulation, we showed that

inducing an epistemic or non-epistemic explanatory goal shifted the domain of the explanation that participants provided. Specifically, religious explanations were generated more readily in response to non-epistemic goals (e.g., offering comfort), while scientific explanations were generated more readily in response to epistemic goals (e.g., evidential support). Many participants responded to non-epistemic goals by generating explanations with explicitly religious sources of comfort (such as an afterlife). By contrast, non-religious participants often succeeded in generating naturalistic sources of comfort (e.g., the idea that we live on in the memories of others) when given a non-epistemic goal, but these explanations were rarely explicitly scientific. Instead, the explanations offered by non-religious participants became more explicitly scientific when they were asked to meet an epistemic goal.

The patterns documented in Studies 1-3 provide unique support for Model 4 (see Figure 4). On the one hand, scientific *and* religious explanations for the existential are attributed *both* epistemic and non-epistemic virtues to the extent they are endorsed (Study 2). This challenges dominant accounts of secularization, as well as the view that science and religion occupy “non-overlapping magisteria” (Gould, 2002). Contra these perspectives, we find that religious explanations are not dissociated from the epistemic, nor are scientific explanations confined to the epistemic. On the other hand, our findings support the idea that science is more strongly associated with explanations that have epistemic virtues (being objective, logical, and based on evidence), while religion is more strongly associated with explanations that have non-epistemic virtues (offering moral, emotional, and social benefits). We found that belief tracks epistemic virtues more

closely for science than for religion (Study 2), and when people are asked to provide logical, evidence-based cause-and-effect explanations, scientific (but not religious) explanations are more often offered (Study 3). By contrast, belief tracks non-epistemic virtues more closely for religion than for science (Study 2), and when people are asked to provide comforting, anxiety-reducing explanations, comforting religious or naturalistic (but not scientific) explanations are more often offered (Study 3).

There are at least two ways to understand the patterns of association just described, not mutually exclusive. The first is that belief in an explanation drives the attribution of virtues. That is, explanations are believed to be based on evidence, to be logical, to offer comfort, and so on *because* they are endorsed. This is consistent with mechanisms posited to underlie motivated reasoning and cognitive dissonance (Kunda, 1990; Cooper, 2007), and would suggest that these mechanisms manifest differently across domains, with a stronger causal force from belief to epistemic attribution for science, and from belief to non-epistemic attribution for religion. The second possibility is that the attribution of virtues drives belief. That is, explanations are endorsed *because* they are believed to be based on evidence, logical, comforting, and so on. On this view, scientific and religious explanations potentially involve different criteria for evaluation (see Metz, Weisberg, & Weisberg, 2018) or thresholds for acceptance (McPhetres, Zuckerman, 2017): while epistemic concerns are especially crucial to acceptance of scientific explanations, non-epistemic concerns may be more crucial for acceptance of religious explanations.

Of course, it may well be that endorsement and the attribution of (non-)epistemic virtues share bidirectional causal relationships, or that both have a common cause. While we find the former possibility especially plausible, our data challenge a version of the latter. In Study 2, we found that the interactions between domain and (non-)epistemic attributions persisted after accounting for both religiosity and more general scientific worldview. This suggests that individual differences in general religious or scientific worldview (and the demographic, personality, or cognitive factors they potentially reflect) do not fully account for the documented relationships between endorsement of explanations and attributions of virtues. Perhaps more telling, however, the patterns of *interaction* in Study 2 rule out the possibility that explanation endorsement (either in general or in a given domain) is simply associated with the indiscriminate attribution of positive virtues. For example, were it the case that those who endorse religious explanations are generally inclined to attribute positive characteristics to religious explanations, we would not predict the differential effects of domain on epistemic versus non-epistemic virtues that we in fact observe.

Our findings help answer longstanding questions about the prevalence of religious belief and its co-existence with scientific belief. Beliefs can serve different purposes, and as documented by research on motivated cognition, beliefs and attitudes can shift in accordance with specific goal-directed motivations (see Kruglanski, 1996; Kunda & Spencer, 2003 for reviews). Similarly, we argue that explanations serve different purposes (Shtulman & Lombrozo, 2016), and we report evidence that explanatory content can shift in accordance to specific explanatory goals (see also Vasilyeva, Wilkenfeld, &

Lombrozo, 2017, for an example outside the religious domain). If religious explanations are perceived (by some) as best suited to serving non-epistemic needs, they are likely to arise and persist in response to such needs. Moreover, to the extent that scientific and religious explanations satisfy complementary needs, they do not have to compete over the same explanatory space.

If co-existence is supported by functional differentiation, we might expect competition to emerge in circumstances where a single goal, either epistemic or non-epistemic, must be satisfied and explanations from both domains are cognitively available. In fact, there is evidence supporting this possibility. Preston and Epley (2009) show that emphasizing the explanatory power of science leads to lower valuation of religion, whereas apparent weaknesses in scientific explanations lead to higher valuation of religion, suggesting a level of competition between the two frameworks for providing epistemically valuable explanations (see also Preston, Ritter, & Hepler, 2013). Similarly, Tracy, Hart, and Martens (2011) found that offering a naturalistic source of meaning blocked the effects of mortality salience on the endorsement of religious explanations for human origins, suggesting that a naturalistic alternative to religion suppressed the need to endorse religion in the face of a non-epistemic need.

Our findings also raise new and important questions about explanations that fall outside the bounds of science and religion. In Study 3, many participants generated “naturalistic” explanations that were not classified as scientific. More generally, domains like philosophy and other humanistic disciplines have the potential to offer explanations and sources of non-epistemic value that are neither religious nor scientific, at least as

narrowly construed. These domains offer rich and largely uncharted territory for exploring the full range of human explanation-seeking and the means by which it can (or cannot) be satisfied.

It is important to acknowledge several limitations of our studies. First, our conclusions are limited by our predominantly Christian sample of adults within the United States. The patterns we show here do not speak to the ways in which factors that vary across cultures or across development impact the specific roles served by religious and scientific explanations. A similar limitation in diversity concerns our study materials. Although the focus on existential questions was particularly informative for our research questions, we cannot safely generalize to religious and scientific explanations more broadly. Finally, while Study 3 successfully induced different explanatory aims, it would be valuable to extend these results to more ecologically valid circumstances.¹³

Conclusion

Francis Collins characterized our best scientific explanation for the origins of the universe as follows: “the universe had a beginning out of nothingness...and has been flying apart ever since” (Collins, 2009). Although the Big Bang theory has accumulated astonishing epistemic credentials – it is consistent with decades of evidence and entailed by our best-supported theories (Silk, 2000) – Collins writes that this origin story

¹³ In fact, we completed a promising but ultimately inconclusive study of this form, treating the COVID-19 pandemic as a circumstance that could create non-epistemic explanatory goals (e.g., offering emotional comfort). We compared explanations for “What happens after we die?” that were generated before the pandemic to those generated during the pandemic. While domain coding generated by participants suggested that religious explanations were more prevalent during (vs. before) the pandemic, we did not replicate this result with our own coding.

itself “cries out for some explanation” (Collins, 2009). For Collins, and for many of our participants, some explanatory desire remains unfulfilled, and religion is best poised to fulfill it. But our studies also show that for the non-religious, scientific explanations can take on non-epistemic virtues, and non-epistemic goals can be satisfied through naturalistic means. When it comes to existential curiosity, neither science nor religion has exclusive rights to explanation.

References

- Atran, S., & Norenzayan, A. (2004). Religion's evolutionary landscape: Counterintuition, commitment, compassion, communion. *Behavioral and Brain Sciences*, 27(6), 713-730. doi:10.1017/S0140525X04000172
- Baron, J. (2020). Religion, cognitive style, and rational thinking. *Current Opinion in Behavioral Sciences*, 34, 64-68. <https://doi.org/10.1016/j.cobeha.2019.12.015>
- Batson, C. D., & Burris, C. T. (1994). Personal religion: Depressant or stimulant of prejudice and discrimination. In M. P. Zanna & J. M. Olson (Eds.), *The psychology of prejudice: The Ontario symposium* (Vol. 7, pp. 149–170). Hillsdale, NJ: Erlbaum.
- Batson, C. D., & Stocks, E. L. (2004). Core psychological functions. *Handbook of experimental existential psychology*, 141.
- Boyer, P. (2007). *Religion explained: The evolutionary origins of religious thought*. Basic Books.
- Bruce, S. (2002). Praying alone? Church-going in Britain and the Putnam thesis. *Journal of Contemporary Religion*, 17(3), 317-328. <https://doi.org/10.1080/1353790022000008244>
- Cadge, W., & Ecklund, E. H. (2006). Religious service attendance among immigrants: Evidence from the New Immigrant Survey-Pilot. *American Behavioral Scientist*, 49(11), 1574-1595. <https://doi.org/10.1177/0002764206288455>
- Carey, S. (1985). *Conceptual change in childhood*. MIT press.

Chaves, M. (1994). Secularization as declining religious authority. *Social forces*, 72(3), 749-774. <https://www.jstor.org/stable/2579779>

[Collins, F. \(2007, April 6\). Collins: Why this scientist believes in God. CNN. Retrieved from https://www.cnn.com/2007/US/04/03/collins.commentary/index.html](https://www.cnn.com/2007/US/04/03/collins.commentary/index.html)

[Collins, F. \(2009, May 4\). Religion and science: conflict of harmony? Pew Forum on Religion and Public Life's Faith Angle Conference, Pew Research Center. Retrieved from https://www.pewforum.org/2009/05/04/religion-and-science-conflict-or-harmony/](https://www.pewforum.org/2009/05/04/religion-and-science-conflict-or-harmony/)

Cooper, J. (2007). *Cognitive dissonance: 50 years of a classic theory*. Sage.

Corriveau, K. H., Chen, E. E., & Harris, P. L. (2015). Judgments about fact and fiction by children from religious and nonreligious backgrounds. *Cognitive Science*, 39(2), 353-382.

Cui, Y. K., Clegg, J. M., Yan, E. F., Davoodi, T., Harris, P. L., & Corriveau, K. H. (2020). Religious testimony in a secular society: Belief in unobservable entities among Chinese parents and their children. *Developmental Psychology*, 56(1), 117-127. <https://doi.org/10.1037/dev0000846>

Davoodi, T., Cui, K. Y., Clegg, J. M., Yan, F. E., Payir, A., Harris, P. L., & Corriveau, K. H. (2020). Epistemic justifications for belief in the unobservable: The impact of minority status. *Cognition*, 200, 104273. <https://doi.org/10.1016/j.cognition.2020.104273>

- Davoodi, T., Jamshidi-Sianaki, M., Abedi, F., Payir, A., Cui, Y. K., Harris, P. L., & Corriveau, K. H. (2019). Beliefs About Religious and Scientific Entities Among Parents and Children in Iran. *Social Psychological and Personality Science*, *10*(7), 847-855. <https://doi.org/10.1177/1948550618806057>
- Davoodi T. & Lombrozo, T. (in prep). Varieties of ignorance: mystery and the unknown in science and religion. *Manuscript in preparation*.
- Farias, M., Newheiser, A. K., Kahane, G., & de Toledo, Z. (2013). Scientific faith: Belief in science increases in the face of stress and existential anxiety. *Journal of experimental social psychology*, *49*(6), 1210-1213. <https://doi.org/10.1016/j.jesp.2013.05.008>
- Freeman, M. A. (2003). Mapping multiple identities within the self-concept: Psychological constructions of Sri Lanka's ethnic conflict. *Self and Identity*, *2*(1), 61-83. <https://doi.org/10.1080/15298860309023>
- Friesen, J. P., Campbell, T. H., & Kay, A. C. (2015). The psychological advantage of unfalsifiability: The appeal of untestable religious and political ideologies. *Journal of personality and social psychology*, *108*(3), 515. <https://doi.org/10.1037/pspp0000018>
- Gervais, W. M., Shariff, A. F., & Norenzayan, A. (2011). Do you believe in atheists? Distrust is central to anti-atheist prejudice. *Journal of personality and social psychology*, *101*(6), 1189. <https://doi.org/10.1037/a0025882>

- Gervais, W. M., Willard, A. K., Norenzayan, A., & Henrich, J. (2011). The cultural transmission of faith: why innate intuitions are necessary, but insufficient, to explain religious belief. *Religion, 41*(3), 389-410.
<https://doi.org/10.1080/0048721X.2011.604510>
- Gervais, W. M., Xygalatas, D., McKay, R. T., Van Elk, M., Buchtel, E. E., Aveyard, M., ... & Bulbulia, J. (2017). Global evidence of extreme intuitive moral prejudice against atheists. *Nature Human Behaviour, 1*(8), 1-6.
<https://doi.org/10.1038/s41562-017-0151>.
- Gill, M., & Lombrozo, T. (2019). Social Consequences of Information Search: Seeking evidence and explanation signals religious and scientific commitments. In *CogSci* (pp. 1837-1843).
- Gopnik, A., Meltzoff, A. N., & Bryant, P. (1997). *Words, thoughts, and theories* (Vol. 1). MIT Press.
- Gottlieb, E., & Mandel Leadership Institute (2007). Learning how to believe: Epistemic development in cultural context. *The Journal of the Learning Sciences, 16*(1), 5-35. <https://doi.org/10.1080/10508400709336941>
- Gottlieb, S., Keltner, D., & Lombrozo, T. (2018). Awe as a scientific emotion. *Cognitive Science, 42*(6), 2081-2094. <https://doi.org/10.1111/cogs.12648>
- Gould, S. J. (2002). *Rocks of ages: Science and religion in the fullness of life*. Ballantine Books.

- Guadagnoli, E., & Velicer, W. F. (1988). Relation of sample size to the stability of component patterns. *Psychological bulletin*, 103(2), 265.
<https://doi.org/10.1037/0033-2909.103.2.265>
- Heiphetz, L., Spelke, E. S., Harris, P. L., & Banaji, M. R. (2013). The development of reasoning about beliefs: Fact, preference, and ideology. *Journal of experimental social psychology*, 49(3), 559-565. <https://doi.org/10.1016/j.jesp.2012.09.005>
- Heiphetz, L., Spelke, E. S., Harris, P. L., & Banaji, M. R. (2014). What do different beliefs tell us? An examination of factual, opinion-based, and religious beliefs. *Cognitive development*, 30, 15-29.
<https://doi.org/10.1016/j.cogdev.2013.12.002>
- Jong, J., Halberstadt, J., & Bluemke, M. (2012). Foxhole atheism, revisited: The effects of mortality salience on explicit and implicit religious belief. *Journal of Experimental Social Psychology*, 48(5), 983-989.
<https://doi.org/10.1016/j.jesp.2012.03.005>
- Kahan, D. M. (2012). Ideology, motivated reasoning, and cognitive reflection: An experimental study. *Judgment and Decision making*, 8, 407-24. <http://dx.doi.org/10.2139/ssrn.2182588>
- Kahan, D. M., Landrum, A., Carpenter, K., Helft, L., & Hall Jamieson, K. (2017). Science curiosity and political information processing. *Political Psychology*, 38, 179-199. <https://doi.org/10.1111/pops.12396>

- Kay, A. C., Gaucher, D., Napier, J. L., Callan, M. J., & Laurin, K. (2008). God and the government: testing a compensatory control mechanism for the support of external systems. *Journal of personality and social psychology*, 95(1), 18.
<https://doi.org/10.1037/0022-3514.95.1.18>
- Kay, A. C., Moscovitch, D. A., & Laurin, K. (2010). Randomness, attributions of arousal, and belief in God. *Psychological Science*, 21(2), 216-218.
<https://doi.org/10.1177/0956797609357750>
- Kay, A. C., Whitson, J. A., Gaucher, D., & Galinsky, A. D. (2009). Compensatory control: Achieving order through the mind, our institutions, and the heavens. *Current Directions in Psychological Science*, 18(5), 264-268.
<https://doi.org/10.1111/j.1467-8721.2009.01649.x>
- Kinnvall, C. (2004). Globalization and religious nationalism: Self, identity, and the search for ontological security. *Political Psychology*, 25, 741-767.
<https://doi.org/10.1111/j.1467-9221.2004.00396.x>
- Kruglanski, A. W., & Webster, D. M. (1996). Motivated closing of the mind: "Seizing" and "freezing". *Psychological review*, 103(2), 263.
<https://doi.org/10.1037/0033-295X.103.2.263>
- Kunda, Z. (1990). The case for motivated reasoning. *Psychological bulletin*, 108(3), 480. <https://doi.org/10.1037/0033-2909.108.3.480>
- Kunda, Z., & Spencer, S. J. (2003). When do stereotypes come to mind and when do they color judgment? A goal-based theoretical framework for stereotype

activation and application. *Psychological bulletin*, 129(4), 522.

<https://doi.org/10.1037/0033-2909.129.4.522>

Larmore, C. (1996). *The morals of modernity*. Cambridge University Press.

Laurin, K., Kay, A. C., & Moscovitch, D. A. (2008). On the belief in God: Towards an understanding of the emotional substrates of compensatory control. *Journal of Experimental Social Psychology*, 44(6), 1559-1562.

<https://doi.org/10.1016/j.jesp.2008.07.007>

Legare, C. H., & Visala, A. (2011). Between religion and science: Integrating psychological and philosophical accounts of explanatory coexistence. *Human Development*, 54(3), 169-184. <https://doi.org/10.1159/000329135>

Liquin, E. G., Metz, S. E., & Lombrozo, T. (2020). Science demands explanation, religion tolerates mystery. *Cognition*, 204.

<https://doi.org/10.1016/j.cognition.2020.104398>

Lombrozo, T. (2006). The structure and function of explanations. *Trends in cognitive sciences*, 10(10), 464-470. <https://doi.org/10.1016/j.tics.2006.08.004>

McCauley, R. N. (2011). *Why religion is natural and science is not*. Oxford University Press.

McPhetres, J., & Zuckerman, M. (2017). Religious people endorse different standards of evidence when evaluating religious versus scientific claims. *Social Psychological and Personality Science*, 8(7), 836-842.

<https://doi.org/10.1177/1948550617691098>

- Metz, Liquin, & Lombrozo (in prep). Distinct profiles of for beliefs about religion vs. science. *Manuscript in preparation*.
- Metz, S. E., Weisberg, D. S., & Weisberg, M. (2018). Non-Scientific Criteria for Belief Sustain Counter-Scientific Beliefs. *Cognitive Science*, 42(5), 1477-1503.
<https://doi.org/10.1111/cogs.12584>
- Newton, T., & McIntosh, D. N. (2013). Unique contributions of religion to meaning. In *The experience of meaning in life* (pp. 257-269). Springer, Dordrecht.
https://doi.org/10.1007/978-94-007-6527-6_20
- Norenzayan, A., & Hansen, I. G. (2006). Belief in supernatural agents in the face of death. *Personality and Social Psychology Bulletin*, 32(2), 174-187.
<https://doi.org/10.1177/0146167205280251>
- Norenzayan, A., & Shariff, A. F. (2008). The origin and evolution of religious prosociality. *science*, 322(5898), 58-62.
<https://doi.org/10.1126/science.1158757>
- Oviedo, L. (2016). Religious attitudes and prosocial behavior: A systematic review of published research. *Religion, Brain & Behavior*, 6(2), 169-184.
<https://doi.org/10.1080/2153599X.2014.992803>
- Park, C. L. (2005). Religion as a meaning-making framework in coping with life stress. *Journal of social issues*, 61(4), 707-729. <https://doi.org/10.1111/j.1540-4560.2005.00428.x>

Pennycook, G., Cheyne, J. A., Koehler, D. J., & Fugelsang, J. A. (2013). Belief bias during reasoning among religious believers and skeptics. *Psychonomic Bulletin & Review*, 20(4), 806-811. <https://doi.org/10.3758/s13423-013-0394-3>

Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, 123(3), 335-346. <https://doi.org/10.1016/j.cognition.2012.03.003>

[Pew Research Center \(2014\). Worldwide, many see belief in God as essential to morality. Available at https://www.pewresearch.org/global/2014/03/13/worldwide-many-see-belief-in-god-as-essential-to-morality/.](https://www.pewresearch.org/global/2014/03/13/worldwide-many-see-belief-in-god-as-essential-to-morality/)

[Pew Research Center \(2017\). A growing share of Americans say it's not necessary to believe in God to be moral. Available at https://www.pewresearch.org/fact-tank/2017/10/16/a-growing-share-of-americans-say-its-not-necessary-to-believe-in-god-to-be-moral/.](https://www.pewresearch.org/fact-tank/2017/10/16/a-growing-share-of-americans-say-its-not-necessary-to-believe-in-god-to-be-moral/)

[Pew Research Global Attitudes Project \(2007\) Chapter 3: Views of religion and morality. Available: http://www.pewglobal.org/2007/10/04/chapter-3-views-of-religion-and-morality/.](http://www.pewglobal.org/2007/10/04/chapter-3-views-of-religion-and-morality/)

Preston, J. L., Ritter, R. S., & Hepler, J. (2013). Neuroscience and the soul: Competing explanations for the human experience. *Cognition*, 127(1), 31-37. <https://doi.org/10.1016/j.cognition.2012.12.003>

- Preston, J., & Epley, N. (2009). Science and God: An automatic opposition between ultimate explanations. *Journal of Experimental Social Psychology*, *45*(1), 238-241. <https://doi.org/10.1016/j.jesp.2008.07.013>
- Rutjens, B. T., & Preston, J. L. (2020). Science and religion: a rocky relationship shaped by shared psychological functions. In *The Science of Religion, Spirituality, and Existentialism* (pp. 373-385). Academic Press. <https://doi.org/10.1016/B978-0-12-817204-9.00027-5>
- Rutjens, B. T., Van Der Pligt, J., & Van Harreveld, F. (2010). Deus or Darwin: Randomness and belief in theories about the origin of life. *Journal of Experimental Social Psychology*, *46*(6), 1078-1080. <https://doi.org/10.1016/j.jesp.2010.07.009>
- Rutjens, B. T., Van Harreveld, F., Van der Pligt, J., Kreemers, L. M., & Noordewier, M. K. (2013). Steps, stages, and structure: Finding compensatory order in scientific theories. *Journal of Experimental Psychology: General*, *142*(2), 313. <https://doi.org/10.1037/a0028716>
- Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: Cognitive style influences belief in God. *Journal of Experimental Psychology: General*, *141*(3), 423. <https://doi.org/10.1037/a0025391>
- Shtulman, A. (2013). Epistemic similarities between students' scientific and supernatural beliefs. *Journal of Educational Psychology*, *105*(1), 199. <https://doi.org/10.1037/a0030282>

- Shtulman, A., & Lombrozo, T. (2016). Bundles of contradiction: A coexistence view of conceptual change. *Core knowledge and conceptual change*, 49-67.
<https://doi.org/10.1.1.713.776>
- Silk, J. (2000). *The big bang*. Macmillan.
- Stark, R., & Bainbridge, W. (1996). *A theory of religion*. Rutgers University Press.
- Tetlock, P. E. (2002). Social functionalist frameworks for judgment and choice: intuitive politicians, theologians, and prosecutors. *Psychological review*, 109(3), 451.
- Tetlock, P. E. (2003). Thinking the unthinkable: Sacred values and taboo cognitions. *Trends in cognitive sciences*, 7(7), 320-324.
[https://doi.org/10.1016/S1364-6613\(03\)00135-9](https://doi.org/10.1016/S1364-6613(03)00135-9)
- Tracy, J. L., Hart, J., & Martens, J. P. (2011). Death and science: The existential underpinnings of belief in intelligent design and discomfort with evolution. *PloS one*, 6(3), e17349.
<https://doi.org/10.1371/journal.pone.0017349>
- Tsang, J.-A., Rowatt, W. C., & Shariff, A. (2015). *Religion and prosociality*. In D. A. Schroeder & W. G. Graziano (Eds.), *Oxford library of psychology. The Oxford handbook of prosocial behavior* (p. 609–625). Oxford University Press.
<https://doi.org/10.1093/oxfordhb/9780195399813.013.013>

- Vail, K. E., Rothschild, Z. K., Weise, D., Solomon, S., Pyszczynski, T., & Greenberg, J. (2010). A terror management analysis of the psychological functions of religion. <https://doi.org/10.1177/1088868309351165>
- Valdesolo, P., Park, J., & Gottlieb, S. (2016). Awe and scientific explanation. *Emotion*, *16*, 937. <https://doi.org/10.1037/emo0000213>
- Van Leeuwen, N. (2014). Religious credence is not factual belief. *Cognition*, *133*(3), 698-715. <https://doi.org/10.1016/j.cognition.2014.08.015>
- Vasilyeva, N., Wilkenfeld, D., & Lombrozo, T. (2017). Contextual utility affects the perceived quality of explanations. *Psychonomic bulletin & review*, *24*(5), 1436-1450. <https://doi.org/10.3758/s13423-017-1275-y>
- Verkuyten, M. (2007). Religious group identification and inter-religious relations: A study among Turkish-Dutch Muslims. *Group processes & Intergroup relations*, *10*(3), 341-357. <https://doi.org/10.1177/1368430207078695>
- Verkuyten, M., & Yildiz, A. A. (2007). National (dis)identification and ethnic and religious identity: A study among Turkish-Dutch Muslims. *Personality and Social Psychology Bulletin*, *33*, 1448-1462. <https://doi.org/10.1177/0146167207304276>
- Woodward, J., "Scientific Explanation", *The Stanford Encyclopedia of Philosophy* (Winter 2019 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2019/entries/scientific-explanation/>.

Wright, J., & Nichols, R. (2014). The social cost of atheism: How perceived religiosity influences moral appraisal. *Journal of Cognition and Culture*, 14(1-2), 93-115.

<https://doi.org/10.1163/15685373-12342112>

Yamane, D. (1997). Secularization on trial: In defense of a neosecularization paradigm. *Journal for the scientific study of religion*, 109-122.

<https://doi.org/10.2307/1387887>

Yonker, J. E., Edman, L. R., Cresswell, J., & Barrett, J. L. (2016). Primed analytic thought and religiosity: The importance of individual characteristics. *Psychology of Religion and Spirituality*, 8(4), 298. <http://dx.doi.org/10.1037/rel0000095>