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Telli Davoodi and Tania Lombrozo

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Telli Davoodi and Tania Lombrozo
Department of Psychology, Princeton University

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 3 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 nonepistemic 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 predicted by 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 nonepistemic merits than are scientific explanations (Study 1), that an explanation's perceived nonepistemic merits are more strongly predicted by 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 nonepistemic 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, science and religion, explanatory coexistence

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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

Telli Davoodi https://orcid.org/0000-0002-1179-5916
Correspondence concerning this article should be addressed to Telli Davoodi, who is now at Wheelock College of Education and Human Development, Boston University, 1 Silber Way, 02215 Boston, United States. Email: telli@bu.edu

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

Characterizing the epistemic and nonepistemic 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., Bruce, 2002; Chaves, 1994; Yamane, 1997;

Larmore, 1996), religion becomes restricted to nonepistemic 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 & Bainbridge, 1996). This suggests that scientific and religious explanations for the existential might play complementary epistemic and nonepistemic 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 nonepistemic 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 (Liquin et al., 2020; Tetlock, 2002, 2003; Van Leeuwen, 2014; McCauley, 2011), including the perceived coexistence 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.

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, 2017; for similar points concerning folk explanations, see Carey, 1985; Gopnik & Melzoff, 1998; 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 (Batson & Stocks, 2004; Newton & McIntosh, 2013; Park, 2005). It is widely believed (by laypeople) that religious beliefs support moral behavior (Pew Research Global Attitudes Project, 2007) and (by social scientists) that religious identities define the boundaries of social groups (Argyle & Beit-Hallahmi, 2013; Batson & Burris, 1994; Verkuyten, 2007). These observations suggest that religious explanations might play *nonepistemic* 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 nonepistemic dimensions. Illustrating the former, scientific beliefs are more likely than religious beliefs to be justified by appeal to evidence (Metz et al., 2021; Metz et al., 2018; Shtulman, 2013), are more strongly associated with inquiry (Davoodi & Lombrozo, 2021; Liquin et al., 2020; Gill & Lombrozo, 2019), and are more likely to be perceived as objectively true (Heiphetz et al., 2013; see also Heiphetz et al., 2014; Friesen et al., 2015; Gottlieb & Mandel Leadership Institute,

2007). Perhaps reflecting these different attitudes toward belief, studies have found that across a number of cultures, scientific beliefs tend to be held with greater confidence than religious beliefs (Cui et al., 2020; Davoodi et al., 2019; Harris, 2012; Harris et al., 2006).

On the side of nonepistemic 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 et al., 2010; Laurin et al., 2008; Rutjens et al., 2010) or a mortality prime (Norenzayan & Hansen, 2006; see also Vail et al., 2010; Jong et al., 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 (Gervais et al., 2017; Pew Research Center, 2014, 2017; Wright & Nichols, 2014; see also Gervais et al., 2011) and on many frameworks are in fact tied to prosocial behavior (e.g., see Oviedo, 2016; Tsang et al., 2015). More indirect evidence for the nonepistemic role of religion is found in work showing that religious involvement influences social integration (Verkuyten & Yildiz, 2007) and signals social commitment and identity (see e.g., Cadge & Ecklund, 2006; Cui et al., 2020; Freeman, 2003; Kinnvall, 2004).

Given these associations between science and epistemic virtues, on the one hand, and religion and nonepistemic 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 nonepistemic 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 nonepistemic merits indirectly. Moreover, prior work has rarely contrasted religion and science within the same design, especially when it comes to assessing the nonepistemic 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 nonepistemic virtues.

Evaluating Existential Explanations: Effects of Belief

Even if scientific explanations are associated with epistemic virtues and religious explanations with nonepistemic 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

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 Nonepistemic Virtues
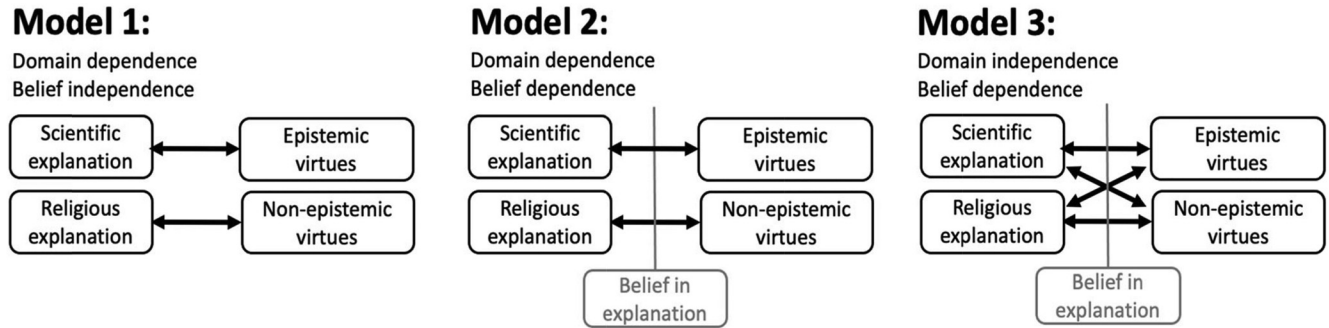
Note. Models 2 and 3 include a role for belief, such that endorsement of a given explanation governs the extent to which it is attributed epistemic or nonepistemic virtues, where attribution additionally depends on domain in Model 2, but not in Model 3. In Study 1, we operationalize belief in religious explanations through a measure of religiosity. In Study 2, we measure belief in a given explanation directly.

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 et al., 2018; Shenhav et al., 2012). On the flipside, there is some evidence that scientific beliefs—like religious beliefs—can offer a sense of control (Rutjens et al., 2010; Rutjens et al., 2013), reduce existential anxiety (Farias et al., 2013; Tracy et al., 2011), define cultural identity (Kahan, 2013; Kahan et al., 2017), offer a sense of meaning (Rutjens & van Elk, 2019; as cited in Rutjens & Preston, 2020), and support experiences of awe (Gottlieb et al., 2018; Valdesolo et al., 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 nonepistemic 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 nonepistemic to religion. Because these possibilities remain largely untested, it is an open question whether and how scientific explanations might satisfy nonepistemic dimensions of existential curiosity and indeed whether the nonreligious turn to science (vs. other 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 nonepistemic 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 nonepistemic virtues but also differentially generated in response to epistemic aims (such as offering evidential support) versus nonepistemic aims (such as offering emotional comfort). Study 3 also allows us to take a closer look at how the nonreligious generate explanations in response to nonepistemic 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 coexist versus compete.

Study 1

In Study 1, we investigated the (perceived) epistemic and nonepistemic 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 nonepistemic 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 nonepistemic 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).

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 seventh 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."

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 nonepistemic 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 nonepistemic 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 preregistered and are available at [https://osf.io/bnyrx/]. Departures from preregistered analyses are noted.

Participants

Participants were 501 adults (246 female, 249 male, 6 nonbinary, 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 supplementary materials 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 supplementary materials 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 preregistered procedure for developing this stimulus set is described in detail in the online supplementary materials (Section I.I).

Procedure

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

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[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.

Table 2

Explanation Rating Items From Study 1 Clustered by Factor, With Corresponding Factor Loadings

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 (Nonepistemic)
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 (Nonepistemic)
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 (Nonepistemic)
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 (Nonepistemic)
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 (Nonepistemic)
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.		

Note. Statements with asterisks were reverse-scored in composite scores.

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 nonreligious participants and, in particular, to disambiguate whether low ratings for religious explanations along nonepistemic dimensions (if observed) reflected lack of personal belief in the explanation or a rejection of the connection between the explanation's content and nonepistemic 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

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 Development 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* = .02, *RMSEA* = .04, *Tucker Lewis Index* = .96, *p* < .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 preregistered criteria, we decided to keep factors with stable scores and to eliminate items with factor loadings less than .4 (see Guadagnoli & Velicer, 1988).

Among the seven factors that emerged, there were two interpretable epistemic factors (evidential support and objectivity) and five interpretable nonepistemic 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.

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 × 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 online 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 (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.

Nonepistemic Composites

For all nonepistemic composites except for Accountability, we observed main effects of domain, such that religious explanations were on average judged to possess more nonepistemic virtues than scientific explanations (see Figure 2). However, ratings for all nonepistemic 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 nonepistemic virtues to religious explanations than to scientific explanations, while lower levels of religiosity involved an attenuation or reversal of this effect.

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 (α = .77, 95% CI [.73, .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* = −.42, *SE* = .07, *t* = −6.20, *p* < .001, 95% CI [−.56, .29]), with higher ratings for religion than for science, but the interaction between Religiosity and Domain was not (*B* = −.07, *SE* = .06, *t* = −1.09, *p* = .28, 95% CI [−.18, .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 nonepistemic virtues

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[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 online supplementary materials for presentation of analyses as preregistered.

[3] There was also a significant interaction between Question and Domain, *F*(2, 492) = 10.21, *p* < .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 supplementary materials).

Table 3
Regression Model Results for Each of the Seven Factors in Study 1

Model component	Evidential support (epistemic)	Objectivity (epistemic)	Social support (nonepistemic)	Emotional comfort (nonepistemic)	Self & identity (nonepistemic)	Moral world (nonepistemic)	Accountability (nonepistemic)
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)***	0.21 (0.09)*	−0.55 (0.09)***	−0.53 (0.10)***	−0.21 (0.09)*	−0.49 (0.10)***	−0.10 (0.10)
	CI [0.60, 0.92]	*CI [0.60, 0.92]*	*CI [−0.68, −0.42]*	*CI [−0.69, −0.36]*	*CI [−0.39, −0.03]*	*CI [−0.69, −0.29]*	*CI [−0.29, 0.10]*
Religiosity	0.51 (0.05)***	0.31 (0.06)***	0.16 (0.04)***	0.29 (0.05)***	0.72 (0.06)***	0.55 (0.06)***	0.13 (0.06)*
	CI [0.41, 0.61]	*CI [0.19, 0.42]*	*CI [0.08, 0.25]*	*CI [0.18, 0.39]*	*CI [0.61, 0.84]*	*CI [0.43, 0.68]*	*CI [0.01, 0.25]*
Domain × Religiosity	−0.59 (0.07)***	−0.26 (0.08)**	−0.08 (0.06)	−0.35 (0.08)***	−0.62 (0.08)***	−0.54 (0.09)***	−0.58 (0.09)***
	CI [−0.73, −0.45]	*CI [−0.43, −0.10]*	*CI [−0.20, 0.04]*	*CI [−0.50, −0.20]*	*CI [−0.78, −0.46]*	*CI [−0.71, −0.36]*	*CI [−0.75, −0.40]*
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 × 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)*
Adjusted R²	*0.30*	*0.07*	*0.16*	*0.20*	*0.24*	*0.16*	*0.13*
F	*32.09***	*6.009***	*14.51***	*18.97***	*23.21***	*14.48***	*11.28****

Note. For Domain, "Religion" was always set as the reference category. 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. We indicate model components in bold, and additional statistics in italics (adjusted R^2 and F).
$* p < .05.$ $** p < .01.$ $*** p < .001.$

Figure 2

*Mean Composite Score for Each Factor by Domain in Study 1*
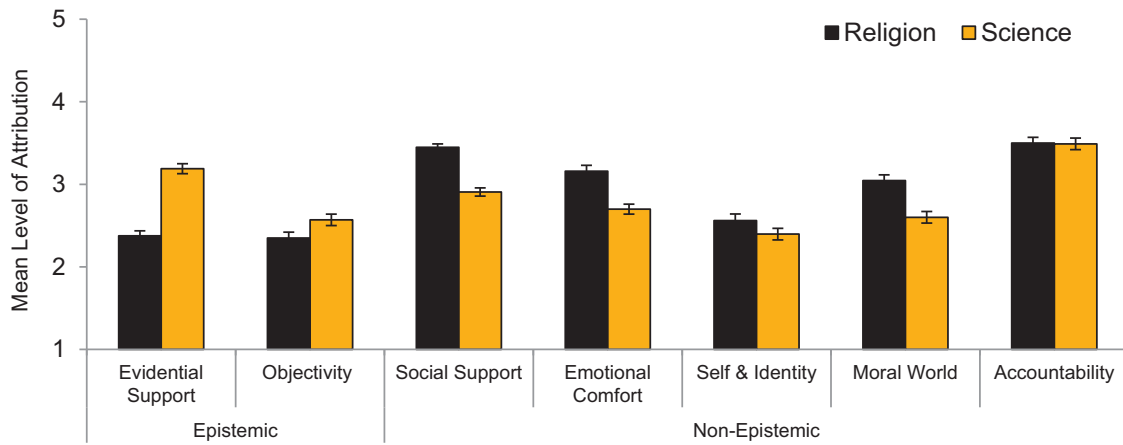
Note. Error bars indicate +/−1 *SEM*. See the online article for the color version of this figure.

(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 nonreligious; for the religious, both kinds of explanations were attributed moderate levels of evidential support and objectivity. By contrast, the greater attribution of nonepistemic virtues to religious (vs. scientific) explanations was driven by the religious; for the

nonreligious, 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

Figure 3

Moderating Effects of Participants' Self-Reported Level of Religiosity on Explanation Ratings for Epistemic Items (Left Column) and Nonepistemic Items (Middle and Right Columns) as a Function of Explanation Domain (Religion, Science) for Study 1
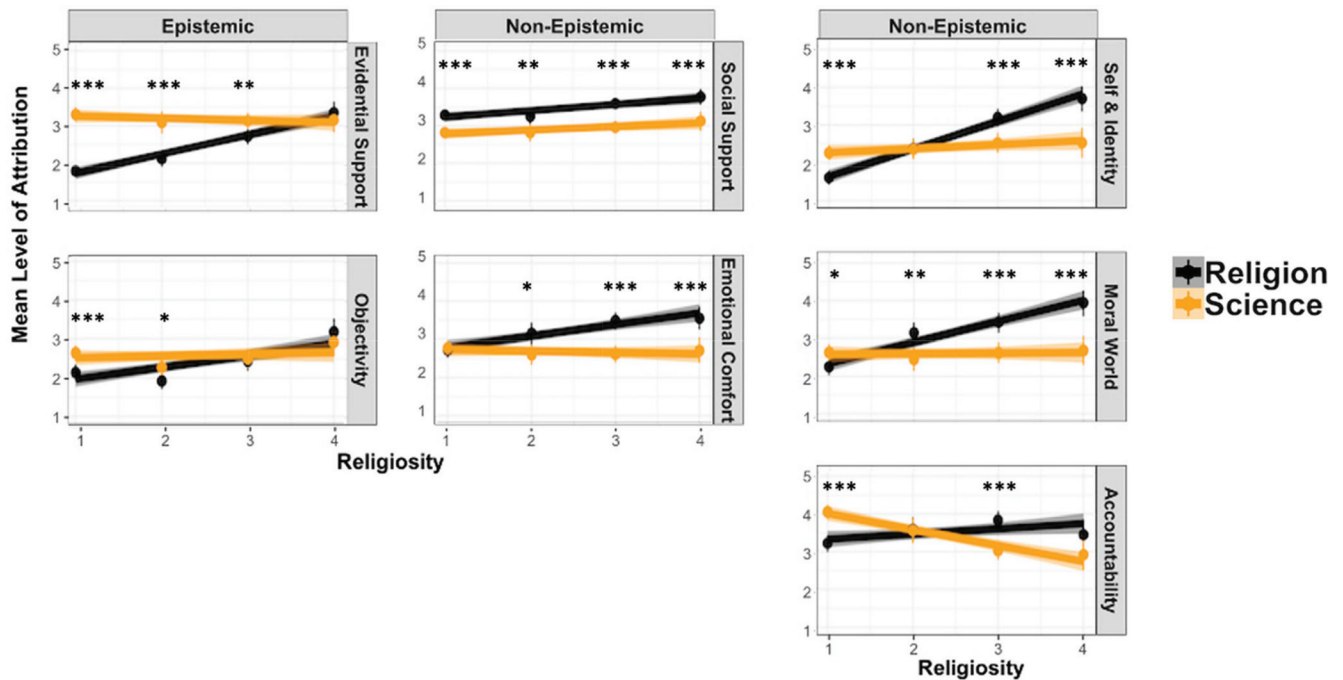
Note. Dots represent means at each level of Religiosity. Error bars represent 95% confidence intervals. The asterisks indicate significant effects of domain with simple slope analyses at each level of religiosity, with * $p < .05$. ** $p < .01$. and *** $p < .001$. See the online article for the color version of this figure.

observed that religiosity was associated not only with higher attributions of nonepistemic 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 nonepistemic 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 nonepistemic 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 nonepistemic 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 nonepistemic virtues are only attributed to religious explanations. Study 2 provides a direct test of both models.

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 et al., 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 pretested 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 nonepistemic 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 nonepistemic virtues in both domains, the effect for epistemic virtues should

be stronger for science than for religion, whereas the effect for nonepistemic 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 nonepistemic 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 preregistered and are available at https://osf.io/bxg87/.

Participants

Participants were 652 adults (322 female, 316 male, 14 non-binary; M_{Age} = 33 years, SD_{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."

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 nonepistemic 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 nonepistemic 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

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 Nonepistemic Virtues
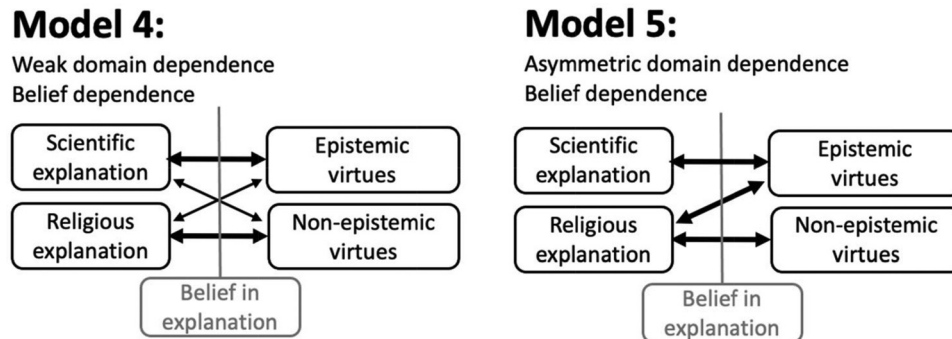
Note. As in Models 2 and 3, Models 4 and 5 include a moderating role for belief, such that endorsement of a given explanation governs the attribution of epistemic or nonepistemic virtues.

Table 2), self and 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 Nonepistemic. 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 ($\alpha = .84$, 95% CI [.83, .86], and $\alpha = .76$, CI [.74, .78], for epistemic and nonepistemic, respectively). We then ran mixed-effects linear regression models, using the *lme* function from the *nlme* package in *R*, separately on each composite (Epistemic, Nonepistemic), 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 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 ($B = .47$, $SE = .05$, $t = 10.02$, $p < .001$, 95% CI [.38, .47]; see Figure 5), with higher ratings for science than for religion, and a significant effect of Endorsement ($B = .45$, $SE = .02$, $t = 25.54$, $p < .001$, 95% CI [.42, .49]), as well as the predicted interaction between these two factors ($B = .11$, $SE = .03$, $t = 4.11$, $p < .001$, 95% CI [.06, .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 ($B = .44$, $SE = .02$, $t = 26.04$, $p < .001$, 95% CI [.41, .48]) and also within Science ($B = .55$, $SE = .02$, $t = 27.10$, $p < .001$, 95% CI [.51, .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). It is worth noting, however, that this difference was small, and driven by the more commonly endorsed explanations.[5]

For the attribution of nonepistemic virtues, there was again a main effect of Domain ($B = -.45$, $SE = .04$, $t = -9.78$, $p < .001$, 95% CI [-.54, -.36]) with higher ratings for religion than for

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[4] To complement the analysis of each of the epistemic and nonepistemic composites separately, we also ran another mixed-effects regression model, including a three-way interaction between Domain, Endorsement, and Dimension (epistemic, nonepistemic), 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 ($B = -0.18$, $SE = 0.03$, $t = -5.68$, $p < .001$), which corroborates the results we report from the separate models on the epistemic and nonepistemic composites.

[5] For religious explanations, when we additionally controlled for possible effects of Explanation Type and Order, there were no effects of either ($B = 0.00$, $SE = 0.04$, $t = 0.09$, $p = .92$ and $B = 0.00$, $SE = -0.05$, $t = 0.06$, $p = .44$, respectively), and the effect of Endorsement remained significant ($B = 0.44$, $SE = 0.02$, $t = 25.10$, $p < .001$). For scientific explanations, there was a main effect of Explanation Type ($B = 0.42$, $SE = 0.04$, $t = 9.52$, $p < .001$, 95% CI [0.33, 0.51]) but no effect of Order ($B = -0.09$, $SE = 0.06$, $t = -1.47$, $p = .14$), and the effect of Domain remained significant ($B = 0.47$, $SE = 0.02$, $t = 22.30$, $p < .001$). 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 ($B = 0.16$, $SE = 0.03$, $t = 5.46$, $p < .001$, 95% CI [0.10, 0.22]).

Figure 5

Average Levels of Attribution of Epistemic and Nonepistemic Virtues to Religious and Scientific Explanations in Study 2
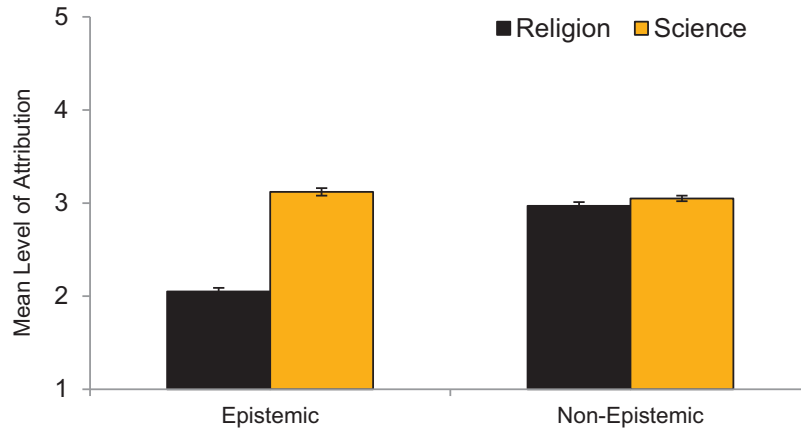

Note. Error bars represent $+/-$ *SEM*. When level of explanation endorsement is considered, an effect of domain on the attribution of nonepistemic virtues additionally emerges (see Figure 6). When averaging across the whole sample, as plotted here, this effect is obscured by the fact that low levels of endorsement were more common for Religion, and high levels of endorsement were more common for Science. See the online article for the color version of this figure.

science, as well as a main effect of Endorsement ($B = .50$, $SE = .02$, $t = 30.47$, $p < .001$, 95% CI [.46, $-.53$]) and the predicted interaction ($B = -.11$, $SE = .02$, $t = -4.11$, $p < .001$, 95% CI [$-.16$, $-.06$]).

Follow-up models within each domain revealed a main effect of Endorsement on nonepistemic attributions for both Religion ($B = .49$, $SE = .02$, $t = 28.84$, $p < .00$, 95% CI [.46, .53]) and for Science ($B = .39$, $SE = .02$, $t = 22.52$, $p < .001$, 95% CI [.36, .42]), such that more strongly endorsing an explanation was associated with higher attributions of nonepistemic virtues to that explanation (emotional comfort, moral benefits, etc.), whether that explanation was religious or scientific. However, level of endorsement was

Figure 6

Moderating Effects of Explanation Endorsement on the Attribution of Epistemic (Panel A) and Nonepistemic (Panel B) Virtues to that Explanation in Each Domain (Religion, Science) in Study 2
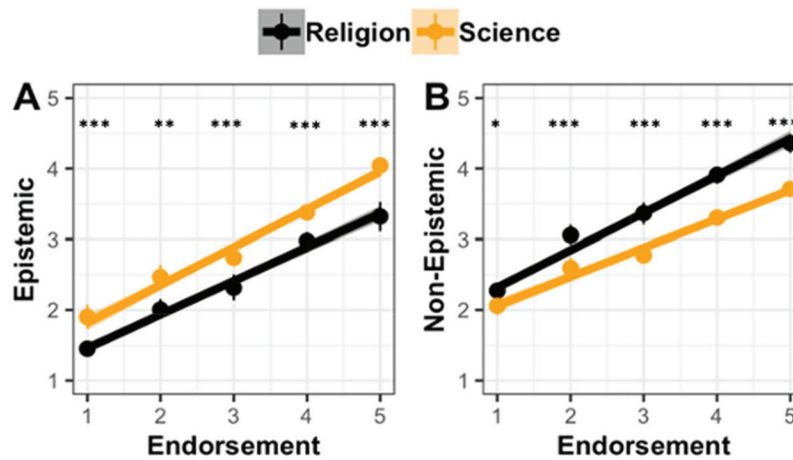
Note. Dots represent means at each level of Endorsement. Error bars represent 95% confidence intervals. The asterisks indicate significant effects of domain with simple slope analyses at each level of endorsement, with * $p < .05$. ** $p < .01$. and *** $p < .001$. See the online article for the color version of this figure.

more strongly associated with the attribution of nonepistemic virtues for religious explanations than for scientific explanations.[6]

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 nonepistemic 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 Nonepistemic virtues, the interaction between Domain and Endorsement remained significant ($B =$ .17, $SE = .03$, $t = 5.86$, $p < .001$, 95% CI [.11, .17] and $B = -.08$, $SE = .03$, $t = -2.99$, $p = .003$, 95% CI [−.13, −.03], respectively).

To ask if results from Study 1 replicate in Study 2, we also ran an additional model with the Religiosity × Domain interaction. The moderating effect of Religiosity on Domain for both Epistemic and Nonepistemic ratings was consistent with the results from Study 1 (see section II.II and Figure S4 in the online supplementary materials).[7]

Discussion

The findings from Study 2 reveal that endorsing the truth of a religious explanation is associated with judging that explanation to possess nonepistemic 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 nonepistemic virtues (consistent with Models 3–4). Finally, they reveal that endorsement is differentially predictive of virtue type (epistemic vs. nonepistemic) depending on the explanation's domain. In particular, endorsement is a stronger predictor of nonepistemic 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 nonepistemic virtues, with a stronger association between science and the epistemic and between religion and the nonepistemic (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, as well as robust effects of domain across Studies 1 and 2, is it case that epistemic explanatory goals (e.g., aiming for evidential and logical support) prompt more scientific explanations and that nonepistemic 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 nonepistemic explanatory goals but no systematic effects of domain given epistemic explanatory goals).

Second, Study 3 allows us to ask how the nonreligious satisfy nonepistemic 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., Farias et al., 2013; Tracy et al., 2011). However, it remains unclear whether the nonreligious typically satisfy nonepistemic needs by appealing 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 nonreligious explanations offered in response to nonepistemic 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 nonepistemic characteristics (e.g., peace of mind, emotional comfort). As a baseline, we also included a third condition that did not prompt either epistemic or nonepistemic 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 nonepistemic 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 preregistered and are available at [https://osf.io/vmr4y/].

Participants

Participants were 494 adults (241 female, 249 male, 4 nonbinary, $M_{Age} = 39$ years, $SD_{Age} = 13$ 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

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[6] There were no effects of Explanation Type or Order on the attribution of Nonepistemic 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.

[7] Additionally, we asked how Scientific Outlook might moderate the effect of Domain for epistemic and nonepistemic ratings. See section II.II and Figure S5 in the online supplementary materials. Scientific Outlook moderates ratings in a pattern opposite to that observed for Religiosity.

studies (including studies reported in the online supplementary materials 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 (nonepistemic, control, epistemic). In all three conditions, participants were encouraged to answer their designated question by focusing on specific explanatory goals.

In the nonepistemic 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 nonepistemic

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 nonepistemic items ("has positive emotional implications," "has negative emotional implications," with the latter reverse-coded). We included additional epistemic and nonepistemic 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 supplementary materials (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 Coding

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. This coding was conducted for exploratory purposes. The coding categories were not determined prior to the experiment, nor were the associated analyses pre-registered. 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 cannot 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 (κ = .72, $p < .001$, for both religious and scientific content).

To better understand how both religious and nonreligious participants tailored their explanations to meet nonepistemic 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 (κ = .68, $p < .001$).

Results

Manipulation Check

First, we note that the experimental manipulation was effective in the sense that participants in the nonepistemic focus condition (vs. control) more strongly agreed that their explanations included the instructed nonepistemic 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 nonepistemic focus condition, epistemic features were suppressed, relative to control). The full results for these measures are reported in the online supplementary materials (section III.I.I).[8]

Analytic Approach

We investigated the effect of focus condition (Nonepistemic, 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 Figure 7). Religion/science ratings were considered in separate models.[9] Notably, for these analyses, patterns were consistent across the three Questions (see Figure S9 in the online 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 × Condition interaction; these patterns are presented in the online supplementary materials (Section III.I.IV).

Effects of Condition on Participants' Domain Ratings

For religion ratings, there was a main effect of condition (Control vs. Nonepistemic: B = .74, SE = .24, t = 3.04, p = .002, 95% CI [.26, 1.22]; Control vs. Epistemic: B = −.70, SE = .25, t = −2.82, p = .005, 95% CI [−1.19, −.21]). Explanations in the nonepistemic 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 Nonepistemic condition (B = −1.44, SE = .25, t = −5.82, $p < .001$). 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 supplementary materials).

Science ratings similarly revealed the predicted effect of condition (Control vs. Nonepistemic: B = −.68, SE = .23, t = −2.89, p = .004, 95% CI [−1.13, −.22]; Control vs. Epistemic: B = 1.04, SE = .24, t = 4.33, $p < .001$, 95% CI [.57, 1.51]). Explanations in the Nonepistemic 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 Nonepistemic condition (B = −1.44, SE = .25, t = −5.82, $p < .001$).

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 supplementary materials).

### Relationship Between Condition and Comfort Coding

To investigate how sources of comfort were offered (especially in the Nonepistemic 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 Nonepistemic condition and less often in the Epistemic condition, compared to Control (B = 1.86, SE = .34, z = 5.47, $p < .001$, CI [1.23, 2.58],

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[8] 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.

[9] 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, $p < .001$) and when the control condition is compared to the Nonepistemic condition (B = −1.42, SE = 0.33, t = −4.25, $p < .001$). This pattern of interaction corroborates the results we report from the separate models on the scientific and religious ratings separately.

Figure 7

Participants' Average Ratings of "Belongs to the Domain of Religion" and "Belongs to the Domain of Science" for Generated Explanations in Each Condition in Study 3
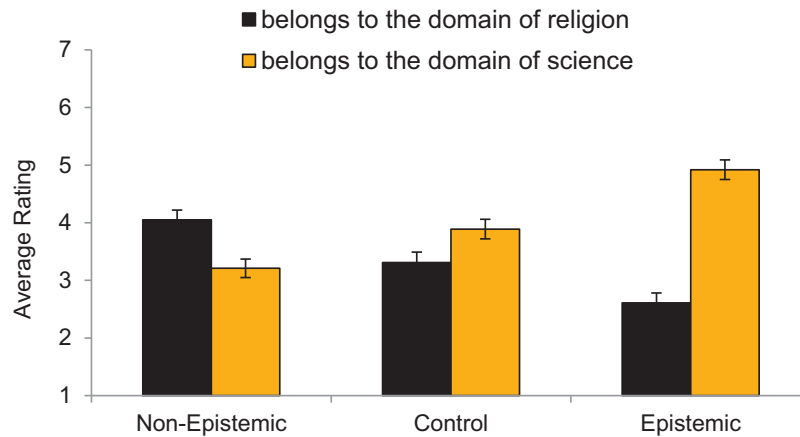
Note. Error bars indicate $+/-1$ *SEM*. See the online article for the color version of this figure.

$OR = 6.46$ and $B = -1.78$, $SE = .25$, $z = -2.18$, $p = .03$, CI $[-1.04, -.06]$, $OR = .17$, respectively; see Figure 8C). In exploratory models including Question, these trends held for all questions (see Figure S12 in the online supplemental materials). Subsequently including Religiosity in the model showed a main effect of Religiosity ($B = .86$, $SE = .16$, $z = 5.28$, $p < .001$), 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 Nonepistemic condition and less often generated in the Epistemic condition, compared to control ($B = 1.32$, $SE = .32$, $z = 4.10$, $p < .001$, CI $[.71, 1.97]$, $OR = 3.73$ and $B = -1.09$, $SE = .53$, $z = -2.06$, $p = .04$, CI $[-2.23, -.12]$, $OR = .33$, 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 ($\chi2 = 14.98$, $p = .005$), 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 supplemental materials). Controlling for the interaction with Question, the main effect of condition remained significant with the predicted pattern and with a main effect of Religiosity ($B = -.57$, $SE = .16$, $z = -3.6$, $p < .001$), such that more religious participants were less likely to generate explanations featuring elements of natural comfort.

In the Nonepistemic 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 ($\chi^2 = 1.49$, $p = .23$) and cannot fully explain why religious explanations were more prevalent than scientific explanations in the Nonepistemic 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%).[10] So while many participants generated natural sources of comfort, they often did so without any explicit appeal to scientific entities or processes. It is also worth noting that natural sources of comfort were not judged as comforting as their supernatural counterparts: on average, in the Nonepistemic condition, explanations with supernatural sources of comfort were more strongly judged to have positive emotional implications ($M = 6.07$, $SE = 0.15$ vs. $M = 5.09$, $SE = 0.19$, $B = 0.97$, $SE = 0.23$, $t = 4.30$, $p < .001$, CI $[0.52, 1.42]$) and less strongly judged to have negative emotional implications ($M = 1.47$, $SE = 0.15$ vs. $M = 2.13$, $SE = 0.17$, $B = -0.64$, $SE = 0.21$, $t = -2.98$, $p = .003$, CI $[-1.06, -0.21]$).

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 nonepistemic 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 nonepistemic 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

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[10] 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."

Figure 8

Percentages of Explanations With Each Coded Category of (A) Religious Content and (B) Scientific Content, and Comfort (C) as a Function of Condition in Study 3
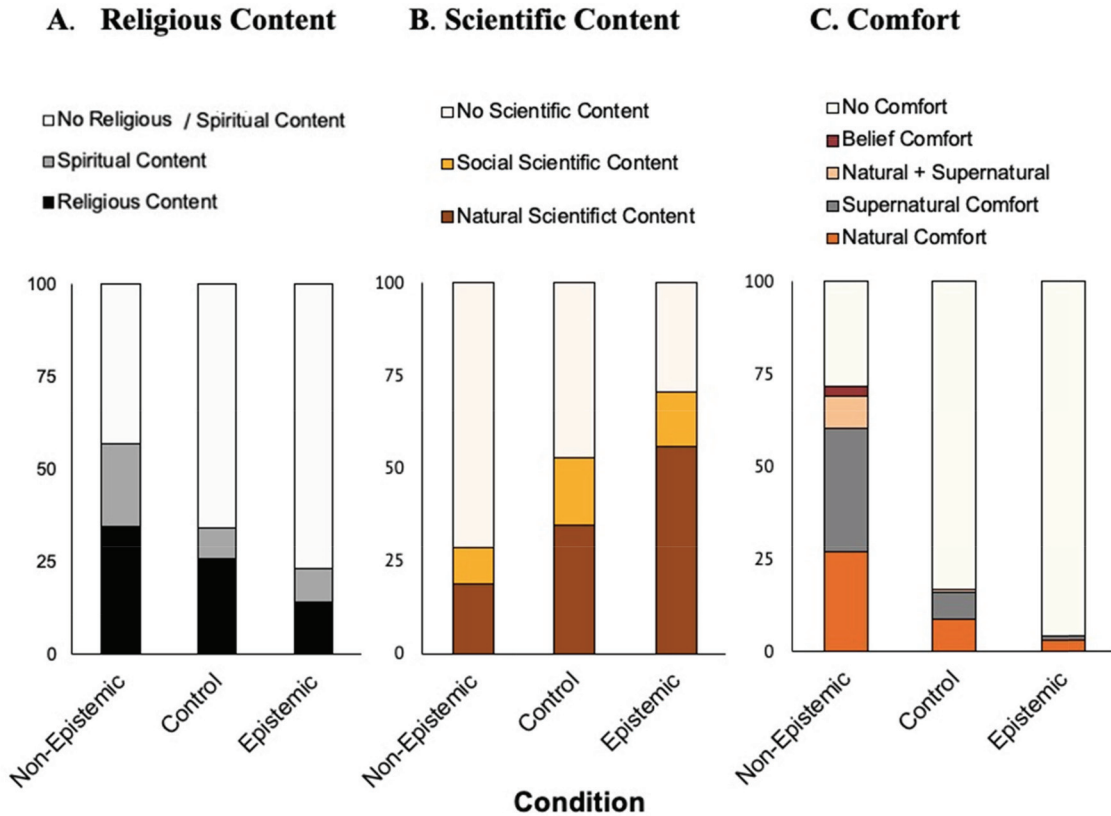
Note. See the online article for the color version of this figure.

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 nonepistemic 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 nonepistemic 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, U.S. adults attribute more epistemic virtues (e.g., evidence, objectivity) to scientific explanations than to religious explanations and more nonepistemic 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 nonepistemic virtues to religious explanations. Nonreligious participants, on the other hand, only attributed epistemic virtues to scientific explanations and did not attribute nonepistemic 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 nonepistemic virtues. However, the magnitudes of these effects varied across domains. Endorsing an explanation more strongly predicted the attribution of epistemic virtues for science (vs. religion) but more strongly predicted the attribution of nonepistemic 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 nonepistemic explanatory goal shifted the domain of the explanation that participants provided. Specifically, religious explanations were generated

more readily in response to nonepistemic 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 nonepistemic goals by generating explanations with explicitly religious sources of comfort (such as an afterlife). By contrast, nonreligious 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 nonepistemic goal, but these explanations were rarely explicitly scientific. Instead, the explanations offered by nonreligious 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 nonepistemic 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 "nonoverlapping magisteria" (Gould, 2002). Contrasting with 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 nonepistemic 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 nonepistemic 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 not mutually exclusive ways to understand the patterns of association just described. 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 (Cooper, 2007; Kunda, 1990) 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 nonepistemic 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 et al., 2018) or thresholds for acceptance (McPhetres & Zuckerman, 2017): While epistemic concerns are especially crucial to acceptance of scientific explanations, nonepistemic 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 nonepistemic virtues that we in fact observe.

Our findings help answer longstanding questions about the prevalence of religious belief and its coexistence 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 & Webster, 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 et al., 2017, for an example outside the religious domain). If religious explanations are perceived (by some) as best suited to serving nonepistemic 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 coexistence is supported by functional differentiation, we might expect competition to emerge in circumstances where a single goal, either epistemic or nonepistemic, 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 et al., 2013). Similarly, Tracy et al. (2011) find 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 nonepistemic 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 nonepistemic 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.[11]

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 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 nonreligious, scientific explanations can take on nonepistemic virtues, and nonepistemic goals can be satisfied through naturalistic means. When it comes to existential curiosity, neither science nor religion has exclusive rights to explanation.

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[11] In fact, we completed a promising but ultimately inconclusive study of this form, treating the COVID-19 pandemic as a circumstance that could create nonepistemic 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.

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