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How is analytical thinking related to religious belief? A test of three theoretical models

Adam Baimel ^a, Cindel J. M. White ^b, Hagop Sarkissian^c, and Ara Norenzayan^b

^aDepartment of Psychology, Health and Professional Development, Oxford Brookes University, Oxford, UK;

^bPsychology Department, The University of British Columbia, Vancouver, Canada; ^cDepartment of Philosophy, Baruch College, City University of New York, New York City, USA

ABSTRACT

The replicability and importance of the correlation between cognitive style and religious belief have been debated. Moreover, the literature has not examined distinct psychological accounts of this relationship. We tested the replicability of the correlation ($N = 5284$; students and broader samples of Canadians, Americans, and Indians); while testing three accounts of how cognitive style comes to be related to belief in God, karma, witchcraft, and to the belief that religion is necessary for morality. The first, *the dual process model*, posits that analytical thinking is recruited in overriding intuitions related to supernatural beliefs. The second, *the expressive rationality model*, posits that analytical thinking is recruited in supporting already-held beliefs in an identity-protective manner. And the third, *the counter-normativity rationality model*, posits that analytical thinking is recruited to question beliefs supported by prevailing cultural norms. In Study 2, we tested the replicability of our results in a re-analysis of published data. The association between analytic thinking style and beliefs was replicated. We conclude that whereas the counter-normativity rationality model was contradicted by the data, both the dual process and expressive rationality models received varying degrees of empirical support, but neither model fully accounted for all the patterns in the data.

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Introduction

What accounts for the emergence of religious beliefs in human minds? This question has long motivated research, and in recent years, a growing literature of interdisciplinary research offers explanations for the ubiquity of religious beliefs in terms of underlying motivational, cultural, and cognitive processes (e.g., Järnefelt et al., 2015; Kay et al., 2010; Norenzayan, 2016; Norenzayan et al., 2016). One of the key insights regarding the cognitive foundations of religious belief is the hypothesis that religious beliefs are partly rooted in interrelated intuitive cognitive biases, such as mind–body dualism, teleology, and anthropomorphism (e.g., Atran & Norenzayan, 2004; Boyer, 2001). In support of this view, evidence is accumulating that these cognitive biases, working together with cultural learning processes, contribute to the proclivity for religious and supernatural beliefs (e.g., Banerjee & Bloom, 2013; Järnefelt et al., 2015; Lindeman et al., 2015; Purzycki, 2013; Willard et al., 2020; Willard & Cingl, 2017; Willard & Norenzayan, 2013; for a recent review, see White et al., 2021).

CONTACT Adam Baimel  abaimel@brookes.ac.uk

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If religious beliefs are rooted in intuitively supported cognitive faculties, and analytical thinking can suppress or override intuitions relevant to supernatural thinking (e.g., Kelemen, Rottman, & Seston, 2013), it follows that the strength of religious belief should be negatively related to analytical thinking. Extensive correlational research supports this inference and demonstrates that tendencies for overcoming the pull of one's intuitions are associated with lower religious belief (e.g., Study 1; Gervais & Norenzayan, 2012; Pennycook et al., 2012; Shenhav et al., 2012). The most common of these findings are centered around a single measure of analytical thinking—the “Cognitive Reflection Test” (CRT; Frederick, 2005). In the CRT, participants are presented with a series of math puzzles (e.g., “If it takes 5 machines 5 minutes to make 5 widgets, how many minutes would it take 100 machines to make 100 widgets?”) to which there is an intuitively compelling but wrong answer (i.e., 100 minutes), and a correct answer (i.e., 5 minutes). Although simple in its design, this measure is reported to reliably differentiate between those who tend to go with their “gut” response and those who are willing to reflect and override their “gut” response (i.e., reason analytically) about the questions—even over time and repeated tests, and controlling for cognitive ability (Stagnaro et al., 2019). And in support of the hypothesis that religious belief is related to intuitive thinking styles, a meta-analysis of 31 studies consisting of mostly North American participants ($N = 15,078$), found that CRT scores were inversely related to religious beliefs ($r = -.18$, .95CI = $[-.21, -.16]$; Pennycook et al., 2016).

The dual process model of religious belief

This correlational evidence forms the core of what can be called the *dual process model of religious belief* (e.g., Norenzayan & Gervais, 2013; Pennycook et al., 2016; Shenhav et al., 2012). In this perspective, the human tendency for religious thinking emerges from the everyday functioning of intuitive cognitive systems, whose output is constrained by careful, effortful reasoning (for this distinction, see Evans & Stanovich, 2013). In its strong version, this model proposes that deliberation and questioning of human intuitions should consistently lead to the rejection of belief. Thus, a core prediction of this model is that, all else being equal, it should be more common that individuals reason their way out of their religious beliefs than it is for individuals to reason their way into them.

However, one need not look deeply into the theological and philosophical record of treatises on religious belief to realize that many religious scholar have deeply reasoned their way into (and/or in maintaining) their religious beliefs. Dating back to the fourth and fifth century, the careful and deeply analytical works of St. Augustine of Hippo, for example, remain a cornerstone of Christian philosophically reasoned arguments for believing in God (e.g., see De Cruz & De Smedt, 2017¹). This raises an important question as to whether there are reliably detectable circumstances under which analytical thinking can promote religious belief rather than dampen it.

The expressive rationality model of religious belief

Much like Augustine—who spent a great deal of time coming up with reasoned arguments defending his conversion to Christianity (Jacoby, 2017)—individuals can be deeply motivated to justify their previously held commitments and beliefs and sometimes go to incredible lengths to confirm their preconceptions (Nickerson, 1998). Although overriding one's intuitions might be a good way to reason through all the available evidence, an alternative account suggests that analytical thinkers might be even better than intuitive thinkers at finding ways to confirm their biases *regardless* of the evidence. Indeed, the *expressive rationality model* holds that individuals deploy their analytical thinking to justify previously held beliefs and that they do so most dramatically when these beliefs are strong indicators of their social affiliations (Kahan, 2017).

That is, rationality can be deployed to confirm already held beliefs as an identity-protective strategy. For example, Kahan and Stanovich (2016) demonstrated that belief in evolution in religious and non-religious Americans is most different (i.e., polarized) amongst analytical thinkers from

either camp. In this view, while analytical thinking might lead nonreligious individuals to question their core intuitions that the design of nature implies supernatural agency (Kelemen, 2004; Kelemen, Rottman & Seston, 2013; Rottman et al., 2016), the same analytical tendency leads religious individuals to endorse supernatural agency with even greater conviction. Indeed, already-devoted analytical thinkers—like Augustine—might prove to be the deepest believers, or at the very least no more or less believing than their intuitive and devoted counterparts. No work—yet—has directly tested whether and how this model applies to belief in God.

The counter-normative rationality model

Moreover, an important limitation of the bulk of the research on the relationship between analytical thinking and religious belief is that it has been conducted with mostly North American and specifically majority Christian samples (with some important exceptions; e.g., studies of Turkish Muslims found results of similar size and magnitude to those reported from American samples; Yilmaz & Saribay, 2016). To test the dual process model of religious belief cross-culturally, Gervais et al. (2017) deployed the CRT and a measure of belief in God in a religiously diverse sample from 13 populations (e.g., Buddhists in Singapore, Hindus in Mauritius, Muslims in the United Arab Emirates, and in secularized nations such as the Czech Republic). In aggregate, Gervais et al. (2017) observed a relationship between analytical thinking and belief in God in the direction predicted by the dual process model of belief; however, the average magnitude of the effect was very small (i.e., an estimated average 2-point decrease on a 100-point scale of belief in God with each additional correct answer on the CRT). While providing some cross-cultural support for the dual process model of religious belief, the observed relationship between CRT and belief was also found to be more strongly negative in more religious countries, and in a few places—such as the UK, the observed relationship was reversed.

From this, Gervais et al. (2017) proposed a third possible account, which can be called the *counter-normative rationality model*. This model says that the *contents* of our intuitions are not just the output of evolved cognitive systems but also (at least in part) the output of culturally learned norms (Henrich, 2015). And thus, it may be that the observed effect of analytical thinking on religious beliefs is an expression of questioning the prevailing norm of religiosity in majority-religiously affiliated cultures (i.e., where most of this research is conducted). In highly secularized cultural contexts—questioning the norms might predict higher religious belief. In line with this, Gervais et al. (2017) found that analytical thinking was weakly but *positively* related to belief in God in a sample of students in the United Kingdom. However, Stagnaro et al. (2019), failed to replicate Gervais et al.'s positive association—in fact, they found the typically sized negative correlation between CRT and belief in God in the United Kingdom in a larger and broader sample of British adults. This additional data, however, does not necessarily rule out the counter-normative rationality's account of the fluctuating magnitude of the relationship as a function of varying levels of normative religiosity.

Testing the three models

The growing record of a robust negative correlation between analytical thinking and religious belief has so far not adequately investigated the cognitive processes that account for this relationship. Moreover, given recent failures to replicate the *causal* (i.e., experimental) effect of induced analytical thinking on disbelief in God in high powered samples and preregistered designs (Sanchez et al., 2017 and Camerer et al., 2018 failing to replicate Gervais & Norenzayan, 2012, Study 2; and Saribay et al., 2020 failing to replicate Shenhav et al., 2012) there is all the more reason to aim for a better theoretical understanding of the underlying psychological processes and moderators of the association between cognitive style and religious beliefs. Based on these considerations, Study 1 had several goals.

First, we tested the dual process model of religious belief by assessing the replicability and magnitude of the correlation between belief in God and cognitive style (measured in two complementary ways—tendencies to think analytically and one's self-reported faith in intuition). In addition, and going beyond existing research, we examined whether the effect of cognitive style extends to other types of religious and supernatural beliefs (i.e., the belief that religion is necessary for morality, belief in karma, and belief in witchcraft). This is important because the dual process model predicts that all types of supernatural beliefs will be negatively correlated with analytic cognitive style, whereas the expressive rationality and counter-normative rationality models do not.

Second, we tested predictions from the expressive rationality model by examining the interaction between cognitive style and political orientation in predicting varied beliefs. Specifically, this model predicts that the relationship between analytical thinking and *identity-relevant beliefs* such as belief in God and the belief that religion is necessary for morality will be moderated by political orientation. These beliefs are both considered a hallmark of political conservatism in North America (e.g., Haidt, 2012) and are more strongly endorsed by the ideological right in many countries (Pew Research Center, 2020). The expressive rationality model predicts that analytical thinking will be *positively* associated with these beliefs amongst politically conservative individuals, but *negatively* associated with these beliefs among politically liberal individuals—as analytical thinking is employed to strengthen existing commitments to identity-relevant beliefs. This interaction thus resulting in widening differences in belief between liberals and conservatives with increasing tendencies for analytical thinking. Otherwise, the expressive rationality model really makes no clear predictions as to whether the relationship between analytical thinking and *non-identity-relevant* supernatural beliefs (e.g., karma/witchcraft beliefs among North Americans) will be similarly moderated by political orientation. Indeed, if the relationship between analytical thinking and supernatural beliefs results *entirely* from the dynamics of identity-protective motivated reasoning as would be proposed by a strong version of the expressive rationality model, then analytical thinking would be unrelated to non-identity-relevant supernatural beliefs. We test for all these possibilities in Study 1.

Third, we tested the counter-normative rationality model in a novel way, by examining the direction of the correlation between cognitive style and belief in *counter-normative* supernatural beliefs—in karma and in witchcraft in samples where these beliefs have markedly different normative status. Specifically, we tested the predictions of counter-normative rationality model that: (1) among majority Hindu Indians (where karmic belief is more normative²) analytical thinking should be *negatively* related to karma beliefs; but, (2) among North Americans (where karmic belief is less normative), analytical thinking should be *positively* related to karma beliefs. Witchcraft beliefs, however, being less normative in both samples, are predicted by this model to be *positively* (or less strongly negatively) related to analytical thinking. In sharp contrast, the dual process model predicts that these associations will be consistently *negative*.

Finally, in Study 2, we tested the replicability of some of the focal results obtained in Study 1 in data that was not collected by our team, through a re-analysis of two previously published and openly accessible datasets (Gervais et al., 2017; Stagnaro et al., 2019).

In both studies, the hypotheses are compared and contrasted in a Bayesian framework that enabled us to determine the relative probabilities with which the data provide evidence in support (or against) the specific predictions of these three models. In doing so, we (1) provide further tests of the replicability of the association between analytical thinking and religious beliefs, in terms of its magnitude and association in previously studied and understudied cultural contexts, and (2) also move beyond documenting the association, to test three distinct psychological accounts of the association between cognitive style and religious beliefs.

Study 1

In Study 1, we tested the predictions of three psychological accounts of the relationship between analytical thinking and religious beliefs in four samples (undergraduate students at a Canadian

university, and broader non-student samples of Canadians, Americans, and Indians). The dual process model of belief predicts that analytical thinking (i.e., greater cognitive reflection and less faith in intuition) will be negatively related to all forms of supernatural beliefs across all samples. The expressive rationality model of belief predicts that (1) the relationship between analytical thinking and identity-relevant supernatural beliefs (e.g., belief in God, and belief that religion is necessary for morality) will be moderated by political orientation (i.e., such that the association is negative for liberals and positive for conservatives), (2) that political orientation will not moderate these associations in the case of non-identity relevant supernatural beliefs and/or that analytical cognitive style will be unrelated to the endorsement of non-identity relevant beliefs. The counter-normative rationality model, on the other hand, predicts that analytical thinking will be *positively* related to endorsement of counter-normative supernatural beliefs.

Methods

Sample

To test these predictions, we identified datasets that we had previously collected which included the relevant variables to examine the association between cognitive style and varied religious/supernatural beliefs. A total of 9 datasets were identified ($N = 5284$; see Table S1 for sample details of each dataset). Participants were: undergraduate students sampled from the University of British Columbia Psychology Department's Human Subject Pool; a national sample of Canadians; two samples of majority Hindu Indians (one sample recruited from Amazon's Mechanical Turk and a broader national sample recruited by an online market research company), and a broad sample of majority Christian Americans (recruited from Amazon's Mechanical Turk). All measures, data analytic choices, and data exclusions are fully disclosed in this article; and materials, data, and analysis scripts are available at <https://osf.io/hpw38/>.

Materials

The presence/absence of the focal measures in each data set is presented in Table S2. Summary statistics of all focal measures are presented in Table S3 and correlations by sample in Table S4, and distributions of responses plotted in Figure S1.

Measures of belief

Across the datasets in Study 1, belief in God was measured on different response scales (5- and 7-point scales). To allow for comparison across response scales, belief in God was linearly recoded to a 0 (minimum belief) to 100 (maximum belief) scale. This type of rescaling was beneficial for two reasons. First, it had the benefit of making all effect size estimates across Study 1 and Study 2 directly comparable (as all examined datasets now employed a 0–100 response scale to measure belief endorsement). Second, alternative rescaling strategies like standardizing responses within datasets would cancel out between dataset mean differences, effectively eliminating the benefits of partial pooling that result from generating estimates and predictions using mixed-effect regression models as we do in our analyses.

In four of the datasets, the belief that religion is necessary for morality was assessed. This 5-item scale asked participants to rate the extent to which they agree with items such as, “Generally speaking, people need religion to be morally good,” and “An individual who does not believe in God cannot lead a moral life” ($\alpha = .96$; full scale included in supplemental materials, Table S5). Across datasets, responses were coded on varying response scales (6- and 7-point scales). As above, responses were recoded on to a 100-point scale. The belief that religion is necessary for morality is prevalent across cultures (Pew Research Center, 2020) and known to be particularly polarizing between North American conservatives and liberals (Pew Research Center, 2014).

Belief in karma was assessed using either the 16-item or 4-item version of a karmic belief scale (White et al., 2018). This scale assesses belief in karma with items such as, “Karma is a force that influences the events that happen in my life,” and “When people experience good fortune, they have brought it upon themselves by behaviour in a past life.” This scale showed good internal consistency across samples ($\alpha = .90-.93$).

Belief in witchcraft was assessed using a 7-item scale ($\alpha = .84-.91$ across samples; e.g., “People can harm others with supernatural power, e.g., by cursing or casting spells on people,” and “If other people have had bad thoughts towards you, it can make you sick”). These items have some overlap with (but are not identical to) previously examined measures of paranormal beliefs that have been reported to be negatively correlated with analytical thinking (Pennycook et al., 2012).

Measures of cognitive style

The Cognitive Reflection Test (Frederick, 2005) is a three-item measure ($\alpha = .75$ across samples) designed to assess capacities and general tendencies for inhibiting intuitive responses and thinking more analytically. The test’s three questions have an intuitively compelling (but wrong) answer (e.g., “If a bat and a ball cost \$1.10, and the bat costs \$1.00 more than the ball, how much does the ball cost?”). Individuals who tend *not* to reflect often give the answer “10 cents” (the modal response). Individuals who do make the effort to reflect are more likely to arrive at the correct answer, “5 cents.” Correct responses are summed, and the total score serves as an index of analytical thinking. This test is commonly used in assessing the association between analytical thinking and religious belief (e.g., Pennycook et al., 2016).

The Faith in Intuition subscale of the Rational Experiential Inventory (Pacini & Epstein, 1999) was included in these datasets as a measure of intuitive cognitive style. This 20-item self-report measure ($\alpha = .96$) asks participants to indicate their agreement with a series of statements reflecting an explicit preference for *not* overthinking and trusting in one’s intuitions (e.g., “I like to rely on my intuitive impressions,” and “I believe in trusting my hunches”). The inclusion of this measure of intuitive thinking style allowed us to test the robustness of the hypothesized association between cognitive style and religious belief. Responses were on varied response scales (5- and 7-point scales) and were first rescaled on to a 0–1 scale for comparison and then *reverse* scored such that higher scores indicated *less* faith in intuition to ease comparisons between this measure and the CRT.

Political orientation

Political orientation was measured across all datasets with a single item that asked participants to indicate whether they were very liberal (1) to very conservative (7) on a Likert-scale.

Results

Analytical strategy and predictions

Our analytical strategy was not pre-registered. As such, our focal regressions include only variables that are directly relevant to testing the predictions of the dual process, expressive rationality, and counter-normative rationality models of religious beliefs (i.e., measures of belief, political orientation, and identifiers for sample and dataset). The publicly available datasets include additional demographic variables (age and sex); and we note that the pattern of results reported here remains unchanged when demographic controls are added to the models. We actively encourage those interested in considering the relationship between these additional variables and our focal predictors to make use of our compiled data.

All analyses were conducted in *R* (R Core Team, 2017). Bayesian mixed-effect linear regression models were executed using the *brms* (Bürkner, 2017) compiler for *RStan* (Stan Development Team, 2017). Model summary tables were generated with *sjPlot* (Lüdtke, 2018). Beliefs were modeled with a random-intercept for dataset (unless data were only available from a single source, in

which case no random-intercept was included). Priors were set as weakly regularizing: fixed effects \sim Normal(0,1); and for variance components for varying effects \sim Exponential(1); which help to minimize overfitting the model to the data in the estimation process (McElreath, 2015, p. 393; Purzycki et al., 2018).

All predictions were tested in models that took one of two forms. The first examined the main effect of analytical thinking on beliefs within each sample by including an interaction term between sample and the measure of analytical thinking (CRT or reverse coded faith in intuition). The second tested for the moderating effect of political orientation (1 = very liberal, 7 = very conservative; standardized) on the relationship between analytical thinking on belief in each sample. The four belief outcomes (belief in God, belief that religion is necessary for morality, belief in karma, and belief in witchcraft), two measures of cognitive style (CRT and faith in intuition), and two model forms resulted in 14 model specifications all of which were run for 2000 iterations (1000 warmup) across four sampling chains that converged across all specifications ($\hat{R}_s < 1.01$). For interested readers, the summaries of all 14 regressions are presented in the supplemental materials: belief in God (CRT—Table S6; Intuition—Table S7), belief that religion is necessary for morality (Table S8), belief in karma (CRT—Table S9; Intuition—Table S10) and belief in witchcraft (CRT—Table S11; Intuition—Table S12). In the main text, we summarize the results of these models by extrapolating and making predictions from the posterior distributions of the estimated contributions of analytical thinking to belief.

In what follows, the reported regression coefficients are the means of the posterior distributions for each parameter estimated by the Bayesian models and can be interpreted as one would a regression coefficient in a frequentist framework. The uncertainty around these point estimates is described by the highest density intervals (95% HDIs). These intervals indicate the range of values that make up the 95% most credible estimates of the parameter in the posterior distribution. By more closely examining the posterior distributions of the model estimated associations of analytical cognitive style and supernatural beliefs in varied contexts (between samples; and within samples in more or less politically conservative individuals), we assessed the extent to which these data support the predictions of the dual process, expressive rationality, and counter-normativity rationality models of belief. Put simply and to summarize:

- (1) The dual process model parsimoniously predicts that all associations between analytical cognitive style and supernatural beliefs will be negative.
- (2) The expressive rationality model predicts that:
 - (a) The association between analytical cognitive style and identity-relevant supernatural beliefs (i.e., belief in God and belief that religion is necessary for morality) will be moderated by political orientation such that the association will be positive in more conservative individuals and negative in more liberal individuals.
 - (b) The association between analytical cognitive style and non-identity relevant supernatural beliefs (i.e., belief in karma and belief in witchcraft among North Americans) will not be moderated by political orientation—and that the main effect of analytical cognitive style on these beliefs will be largely zero.
- (3) The counter-normative rationality model predicts a positive association between analytical thinking and supernatural beliefs that are counter-normative (e.g., belief in karma/witchcraft in the North American samples).

Bayesian regression model evaluations

As a first step to assessing which of these models better accounts for the data—we evaluated our regressions with the *loo* package to estimate out-of-sample prediction accuracy using “leave-one-out” (*loo*) cross-validation (Vehtari et al., 2017). The results (see Table 1) suggest that by and

Table 1. Bayesian model evaluations.

Belief	Predictor	ELPD Difference (SE)	
		Dual process model	Expressive rationality model
God	CRT	-165.2 (16.8)	0
God	Intuition	-172.6 (15.6)	0
Morality	CRT	-153.5 (18.3)	0
Karma	CRT	0	-0.5 (.3)
Karma	Intuition	-14.4 (5.6)	0
Witchcraft	CRT	0	-0.9 (.2)
Witchcraft	Intuition	-16.7 (4.5)	0

Notes: ELPD difference is the difference in expected log predictive densities estimated by the *loo* package (Vehtari et al., 2017). Differences *smaller* than 4 (absolute value) are typically considered to be small and indicative of little to no difference in predictive accuracy. The greater the difference, and smaller the standard error, the larger the difference in predictive performance. "0"s here are indicative of the model with greater predictive performance (e.g., the expressive rationality models in all but two cases where there is no clear indication of any differences). Dual process model estimates are those of models that predicted belief from analytical thinking in each sample; expressive rationality model estimates are those of models that included the additional interaction term between analytical thinking and political orientation in each sample.

large the regressions that included the analytical thinking by political conservatism interaction (in line with the expressive rationality model) had greater predictive performance than regressions that predicted belief only from cognitive style in each sample (i.e., those in line with the dual process model). This indicates that when predicting religious and supernatural beliefs, cognitive style alone is a relatively poorer input than knowing one's political orientation *and* tendencies for analytical thinking. Importantly, these evaluations adjust for differences in the number of parameters between models suggesting that the better predictive performance of the regressions in line with the expressive rationality model is not owed to there being more predictors in the regressions testing the interaction. However, these evaluations do *not* test for the predicted differences regarding the directionality of the estimated association between cognitive style and belief. Given the relatively greater performance of the regressions that included the expressive rationality model's predicted interaction, we next employed the parameter estimates from these regressions to specifically test the directional predictions of the three focal models.

Analysis 1: Dual process model

Figure 1 presents the estimated posterior distributions of the association between analytical thinking (CRT and reverse-scored faith in intuition) and beliefs in all samples at (1) average political orientation, (2) in more liberal (-1 SD), and (3) in more conservative individuals (+1 SD). For the most part, the estimated association is robustly negative for both measures of analytical thinking, varied kinds of belief, in different samples, and at different levels of political orientation. This provides consistent and clear support for the dual process model. Indeed, the posterior probability that at average liberalism-conservatism (i.e., "controlling for political orientation") analytical thinking is negatively associated with belief drops below .98 (i.e., highly probable) only in a single case (the association between witchcraft beliefs and intuition in Indians where the posterior probability = .87, which still mostly supports the dual process model; see Table 2).

Analysis 2: Expressive-rationality model

Returning to Figure 1, the magnitude of the association between analytical thinking and belief is observably moderated by political orientation, but not in the way that the expressive rationality model necessarily predicts (for precise estimates and intervals see Table 2). When comparing more liberal individuals (-1 SD) to more conservative individuals (+1 SD) we do not find that the estimated associations reverse directions for identity-relevant beliefs (belief in God/belief that

Table 2. Estimated regression coefficients and posterior probabilities.

Belief	Predictor	Sample	b_{AVG} [HDI]	$p(b < 0)$	b_{LIB} [HDI]	b_{CON} [HDI]	ΔHDI	$p(b_{LIB} < b_{CON})$
God	CRT	Students	-3.14 [-4.23, -2.12]	.99	-4.22 [-5.70, -2.76]	-2.06 [-3.12, -1.01]	[-3.65, -0.73]	.99
God	CRT	Americans	-5.37 [-6.53, -4.13]	.99	-6.03 [-7.47, -4.37]	-4.70 [-5.78, -3.77]	[-2.47, -0.23]	.98
God	Intuition	Canadians	-2.84 [-3.76, -1.91]	.99	-4.02 [-5.37, -2.75]	-1.65 [-2.93, -0.38]	[-4.25, -0.45]	.98
God	Intuition	Americans	-4.52 [-5.61, -3.48]	.99	-6.26 [-7.56, -4.91]	-2.78 [-4.29, -1.25]	[-5.42, -1.52]	.99
God	Intuition	Indians	-4.60 [-5.87, -3.28]	.99	-6.33 [-8.05, -4.64]	-2.86 [-4.64, -0.83]	[-6.10, -0.88]	.98
Karma	CRT	Americans	-1.78 [-3.23, -0.47]	.98	-1.70 [-3.45, 0.11]	-1.85 [-3.68, -0.05]	[-2.21, 2.51]	.45
Karma	Intuition	Canadians	-5.56 [-6.43, -4.63]	.99	-6.19 [-7.47, -5.00]	-4.92 [-6.08, -3.69]	[-2.91, 0.37]	.90
Karma	Intuition	Americans	-4.70 [-5.68, -3.75]	.99	-6.39 [-7.53, -5.14]	-3.01 [-4.46, -1.61]	[-5.23, -1.59]	.99
Karma	Intuition	Indians	-4.44 [-5.15, -3.62]	.99	-5.14 [-6.02, -4.07]	-3.73 [-4.81, -2.62]	[-2.89, 0.05]	.94
Witchcraft	CRT	Americans	-2.24 [-3.51, -1.02]	.99	-2.22 [-3.87, -0.64]	-2.24 [-3.96, -0.65]	[-2.18, 2.18]	.48
Witchcraft	Intuition	Americans	-2.19 [-3.24, -1.00]	.99	-4.61 [-6.01, -3.22]	0.23 [-1.46, 1.92]	[-7.01, -2.71]	.99
Witchcraft	Intuition	Indians	-0.82 [-2.00, 0.35]	.87	-2.32 [-3.81, -0.60]	0.68 [-1.04, 2.27]	[-5.39, -0.60]	.98
Morality	CRT	Students	-1.82 [-2.57, -1.04]	.99	-2.78 [-3.81, -1.70]	-0.85 [-1.97, 0.17]	[-3.48, -0.40]	.99
Morality	CRT	Americans	-2.74 [-3.43, -2.12]	.99	-3.58 [-4.54, -2.74]	-1.90 [-2.77, -1.06]	[-2.87, -0.50]	.99

Notes: Regression parameters “ b ”s indicate estimated difference in belief on the 100-point response scale (Min = 0; Max = 100) for each additional correct analytical answer on the CRT or a one standard deviation increase in analytical thinking as measured by the Faith in Intuition scale (which was reverse coded so direction of parameters are comparable to those of the CRT). Intervals around these point estimates (HDI) represent the 95% most probable parameter values. Regression parameters are presented for the effects of CRT/Intuition at mean political orientation (b_{AVG} [HDI]), in more liberal individuals (b_{LIB}) and more conservative individuals (b_{CON}), as they are plotted in Figure 1. The difference between more liberal and more conservative individuals is presented in the second to last column (ΔHDI). The posterior probability that the average effect of analytical thinking is *negative* is presented in the “ $p(b < 0)$ ” column. The posterior probability that the effect was stronger in more liberal participants than conservatives is presented in the last column ($p(b_{LIB} < b_{CON})$). Students were recruited from the human subject pool at the University of British Columbia, Canada.

religion is necessary for morality). Moreover, as already noted, we do not find that analytical thinking is *unrelated* to *non-identity* relevant belief sets (belief in karma and witchcraft). In stark contrast to the model’s predictions, it is a *non-identity* relevant belief that shows the greatest probability of being positively associated with analytical thinking (belief in witchcraft in Americans, and also Indians; with most of the more conservative distribution crossing the dashed zero line). However, what we do find is that the magnitude of the associations is more often than not reduced in more conservative as compared to more liberal individuals. Indeed, in all but two cases,³ the posterior probabilities that the association is stronger in more liberal-leaning individuals than it is in more conservative-leaning individuals are greater than .94 (see Table 2).

To follow this up and further unpack the analytical thinking by political orientation interaction, we generated and plotted the predictions made by our regressions at each level of political orientation (Figure 2). In so doing, we find that although we see little support for the prediction of the expressive rationality model that there will be a *positive* association with belief among conservatives (as summarized in Figure 1 and Table 2), we do find that the patterns of belief are at least somewhat in line with the expressive rationality model. Indeed, the predicted *spreading interaction* resulting from a positive association of belief and analytical thinking in more conservative individuals and a negative association in more liberal individuals is evident in a few instances (e.g., belief in God in Students) but a spreading interaction also appeared in what we had considered *non-identity* relevant supernatural beliefs (e.g., belief in witchcraft among Americans). And although this spreading interaction was not consistent across beliefs or samples, it was reliably the case that variance in predicted belief is greater at *high* analytical thinking than at *low* analytical thinking (i.e., the regression lines are more tightly clustered together at low analytical thinking than at high analytical thinking). What this suggests is that without knowing one’s political orientation, the extent of one’s analytical thinking tendencies is a relatively poor predictor of supernatural beliefs. This provides some further indication as to why the regression models that included the analytical thinking by political orientation interaction made more accurate predictions than models of just the main effect of analytical thinking in each sample (Table 1). Moreover, Figure 2 clearly demonstrates that the negative association between analytical thinking and varied beliefs is strongest in the most liberal participants (with the steepest slopes), and the weakest (but only rarely positive)

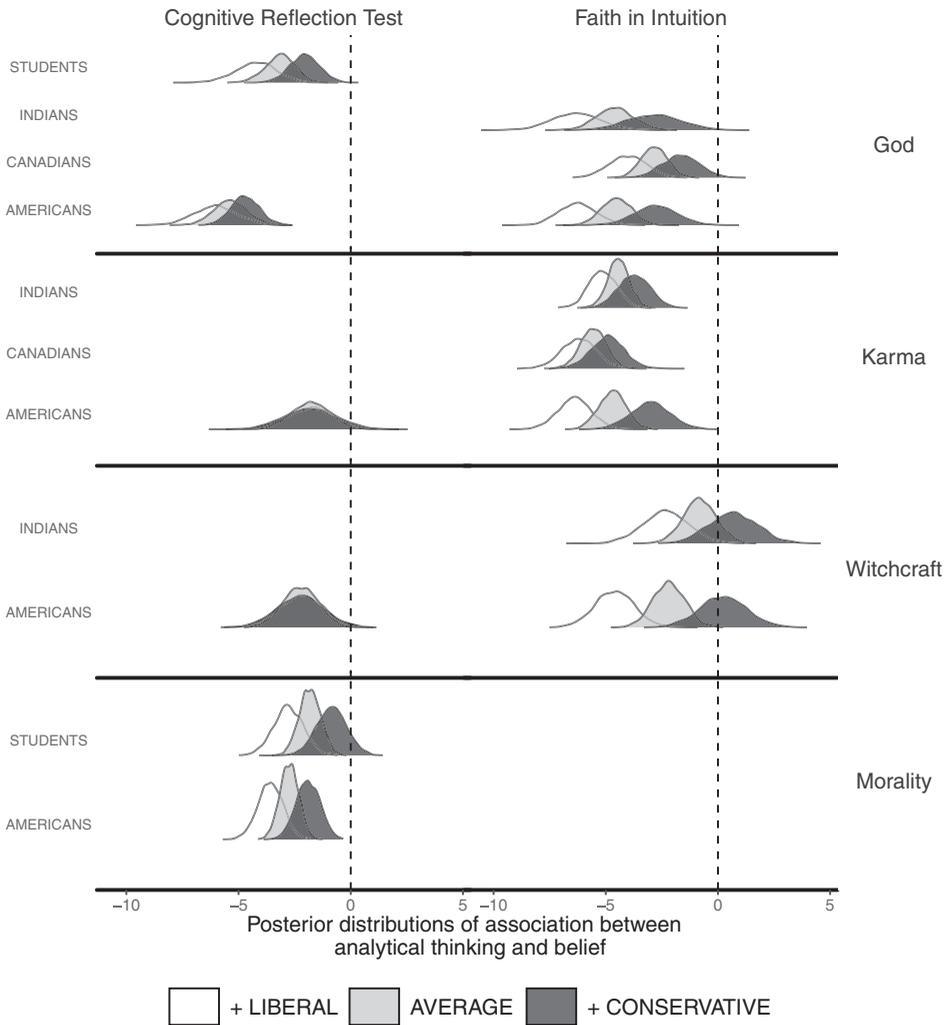


Figure 1. Posterior distribution of the estimated associations between analytical thinking and varied beliefs by sample and political orientation.

Notes: Students were recruited from the human subject pool at the University of British Columbia, Canada. X-axis values are of estimated change in belief with each additional correct answer on the CRT and one standard deviation increase in analytical thinking as measured by the faith in intuition scale which has been reverse scored so the direction of predictions is matched to those of the CRT. With the bulk of the posterior distributions in all instances being to the left of the dashed lines (i.e., below zero), these data largely support the dual process model. The expressive rationality model predicts that the posterior distributions in more conservative individuals for identity-relevant beliefs (belief in God/belief that religion is necessary for morality) would fall to the right of the dashed line (i.e., above zero) - a pattern of results that is not observed here. For more information about these estimates see Table 2.

in the most conservative participants. While these results do not exactly match the predictions of the expressive rationality model, they nonetheless suggest that identity-protective processes are a factor; thus it is important for future research to avoid simply averaging across political orientations.

Analysis 3: Counter-normative rationality model

The identified clear support for the dual process model effectively demonstrates that the predictions of the counter-normative rationality model are *not* supported in this data. We did not find that

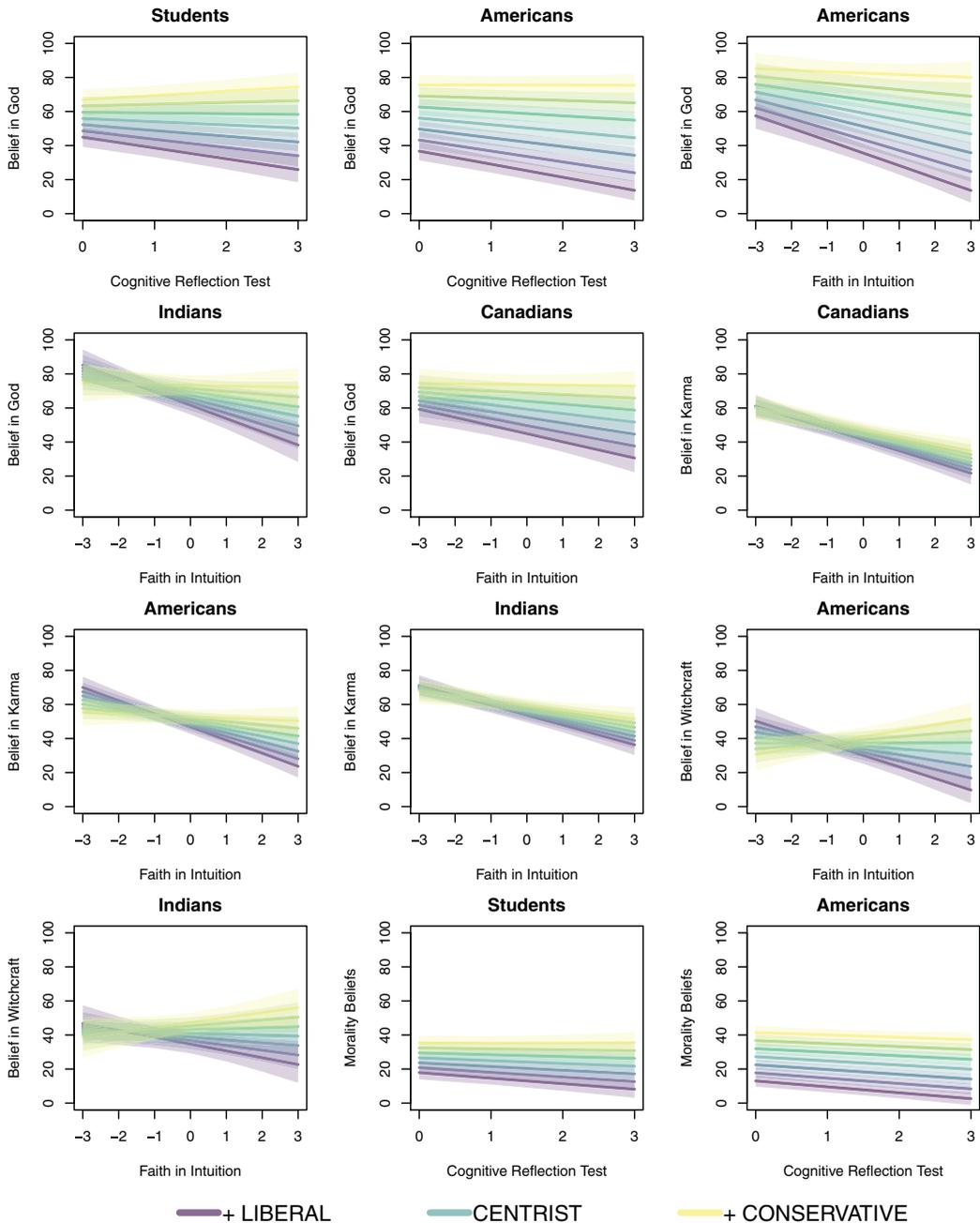


Figure 2. Posterior predictions of belief from analytical thinking and political orientation.

Notes: Predictions estimated from 8000 draws from the posterior distributions of each parameter. Purple lines indicating predictions for the most liberal, yellow lines indicating predictions for the most conservative. Shaded regions are 95% prediction intervals. Students were recruited from the human subject pool at the University of British Columbia, Canada.

endorsement of counter-normative supernatural beliefs were positively related to analytical thinking (i.e., belief in karma and witchcraft were negatively associated with analytical thinking in both the North American and the Indian samples, despite cultural differences in karma's normativity).

Discussion

The results of Study 1 replicate previously reported findings that analytical thinking is negatively correlated with religious and supernatural beliefs in a large and diverse sample. Our results provide further evidence that this association, despite its small magnitude, extends to several types of religious and supernatural beliefs. Moreover, tendencies for analytical thinking (as measured by the Cognitive Reflection Test) and placing faith in one's intuition (as measured in a self-report scale) converged in predicting religious and supernatural beliefs. Taken together, this provides evidence that the association between cognitive style and religious belief is robust to two different cognitive measures. Indeed, while the CRT reliably measures tendencies for overriding one's intuitions, it has somewhat surprisingly been demonstrated to be a relatively poor indicator of individual differences in reliance on intuitions (Pennycook, Cheyne et al., 2016). And thus, the growing body of work that employs the CRT in examining the relationship between analytical thinking and belief in God is better understood as documenting the *negative* association of analytical thinking and belief, and not necessarily the complementary *positive* association of intuition. Here, the consistently observed negative relationships of (reverse scored) self-reported faith in intuition speak to this inverse relationship—that a reliance on one's intuitions is likewise related to belief.

In addition to this complementary relationship between intuition and analytical thinking in predicting belief in God, our results provide evidence that these relationships extend to other types of religious and supernatural beliefs. Analytical thinking was found to be *negatively* related to belief in karma and witchcraft across samples that varied considerably on whether these beliefs are culturally normative, and even to cross-culturally prevalent beliefs that religion is necessary for morality. These consistently negative associations disconfirm the predictions of the counter-normative rationality model that analytical thinking might be employed to question culturally normative beliefs—and provide additional clear support for the dual process model of belief.

While the dual process model of belief was tested in various ways and received support, the results revealed an important limitation of this model in explaining belief. Across diverse belief types and samples, the negative association between analytical thinking and belief was found to be weaker in more conservative individuals. The dual process model is silent about this pattern, and it is particularly striking and non-obvious, given that more politically conservative individuals are reported to rely more heavily on their intuitions, and are generally more religious (Deppe et al., 2015; Haidt, 2012; Nail et al., 2009; Pew Research Center, 2017). Given that the relationship between analytical thinking and belief in God, for example, is reported to be greater in more religious nations (Gervais et al., 2017), it might be expected that the association *within*-samples would be greater amongst more religious sub-samples (i.e., more conservative-leaning individuals) than less religious sub-samples (i.e., liberal-leaning individuals). And thus, if anything, the dual process model, with some extra tweaking, would make the prediction that, *if* there was going to be a difference in the association amongst conservative and liberal individuals, it would be larger (not smaller or reversed) amongst conservatives—a pattern that was not found in our data.

Some, but not all, of our results can instead be accounted for by the expressive rationality model, which argues that analytical thinking is employed not to override intuitions but rather to engage in identity-confirming motivated reasoning (Kahan & Stanovich, 2016). While some of the predictions made from our regression models do generate the spreading interaction predicted by the expressive rationality model for identity-relevant beliefs (e.g., belief in God predicted by the CRT in an undergraduate student sample), we also see some evidence of this spreading interaction in predictions of *non*-identity relevant beliefs (e.g., belief in witchcraft as predicted by faith in intuition in Americans and Indians). This latter result not being directly predicted by the expressive rationality model as formulated here. That being said, our data cannot directly address whether witchcraft beliefs are identity-relevant to conservatives and liberals in India or the USA. Even though we see evidence of the spreading interaction in both samples in Figure 2, witchcraft beliefs are more strongly correlated with political conservatism in Indians ($r = .34$) than in Americans ($r = .06$); suggesting that

different processes may be at play here in these two samples, or even that these results have little to do with identity-protective cognitions. And yet more consistently, what we find is not a spreading interaction resulting from a positive association between analytical thinking and belief in more conservative individuals and a negative association in more liberal individuals but rather a reduction in the magnitude of the association in more conservative as compared to more liberal individuals.

If there is one thing that is abundantly clear in our data, it is that we find no support for the predictions of the counter-normative rationality model. Otherwise, our data support the dual process model, but with the important caveat that the magnitude of the association between analytical thinking and diverse supernatural beliefs are consistently reduced (and in some instances reversed in direction) amongst more conservative individuals than amongst more liberal individuals. Before considering whether this provides evidence for the expressive rationality model, we turn first, in Study 2, to testing the expressive rationality model in two additional datasets in which only the main effect of analytical thinking has been previously reported. The results of Study 1 provide sufficient impetus for researchers to look more closely at the association between cognitive style and belief at different levels of political orientation, rather than merely controlling for it.

Study 2

In Study 2, we tested the predictions of the *expressive rationality model* of religious belief in two additional openly accessible datasets from recently published papers testing the dual process model of belief in diverse samples. The first dataset (Gervais et al., 2017) examined the relationship between belief in God and scores on the Cognitive Reflection Test in 13 samples. Their results demonstrated that the relationship between belief in God and CRT scores is (1) *small*; (2) *variable* across cultures; and (3) that the magnitude of the effect is reduced in less religious nations. Interestingly, these authors reported a surprising reversal: a small *positive* correlation between belief in God and analytical thinking in the United Kingdom. The second dataset (Stagnaro et al., 2019) examined the relationship between belief in God, supernatural beliefs (measured more broadly) and the Cognitive Reflection Test in India and the United Kingdom, controlling for political orientation (as a direct attempt to replicate the surprising reversal reported by Gervais et al., 2017). In India and the United Kingdom (speaking to the non-replicability of the reported reversal from Gervais et al., 2017), Stagnaro et al. (2019) reported a negative correlation between belief in God and analytical thinking that was comparable in size to that expected by the meta-analytic estimates of the relationship. Neither of these papers, however, considered the potential *moderating* effect of political orientation in the relationship between analytical thinking and religious belief. Using their openly accessible data, we tested the predictions of the expressive rationality model of belief in the samples from these datasets where political orientation was assessed (Gervais et al., 2017: Australia, China, Czech Republic, India, Mauritius, Netherlands, and Singapore; and Stagnaro et al., 2019: United Kingdom). Critically, we treat these analyses as an entirely exploratory attempt to replicate the focal results in Study 1 in a broader sample. We made no strong or specific a priori claims as to having insight into the dynamics linking political orientation and religious belief in these diverse cultural settings.

Methods

The published datasets were retrieved from the Open Science Framework: Gervais et al. (2017)—<https://osf.io/v53c4/>; Stagnaro et al. (2019)—<https://osf.io/jb2mr/>. For full sample details, interested readers should refer to their published papers. In both datasets, not all samples included a measure of political orientation and thus we selected only those samples that did. These exclusions left us with 1192 individuals from 7 countries (Australia, China, Czech Republic, India, Mauritius, Netherlands, and Singapore) from the Gervais et al. (2017) dataset; and 523 individuals from the United

Kingdom from Stagnaro et al. (2019) Distribution of responses to the focal measures used in this re-analysis are presented in Figure S2. Our scripts for the re-analysis of these datasets are available at <https://osf.io/hpw38/>.

Measures

In Gervais et al. (2017), belief in God was measured on a 0–100 (max belief) scale, analytical thinking was assessed using the 3-item Cognitive Reflection Test (Frederick, 2005), and political orientation was assessed with a single item (Would you consider yourself more liberal or conservative?) [1 = very liberal; 7 = very conservative]. In Stagnaro et al. (2019), belief in God was measured on a 0–100 (max belief) scale, analytical thinking was assessed using a 7-item Cognitive Reflection Test (Thomson & Oppenheimer, 2016), and political orientation was assessed with two items: “On social issues I am ...” and “On economic issues I am ...” [1 = strongly liberal to 5 = strongly conservative]. These two items were strongly positively correlated, $r(521) = .73$ [.69, .77], $p < .001$ and we took their average as an index of political conservatism. Stagnaro et al. (2019) also measured supernatural belief using the 6-item revised-Supernatural Belief Scale (Jong, Bluemke & Halberstadt, 2013). For all analyses, political orientation was centered (negative values = more liberal; positive values = more conservative).

Analytical models

Analyses were conducted using the same software as in Study 1. Beliefs were modeled using Bayesian mixed-effect linear regressions as conducted in Study 1. For the re-analysis of the Gervais et al. (2017) dataset a random intercept for sample was included (7 countries) in addition to a random slope by country for the effects of CRT, political orientation, and their interaction—to allow all effects to vary across samples. The UK data from Stagnaro et al. (2019) were modeled using Bayesian linear regressions (i.e., with no random effects). Priors were set as uninformative and weakly regularizing: fixed effects \sim Normal (0,1); variance components for varying effects \sim Exponential (1); and for the covariance structure of varying effects \sim LKJ (4); (McElreath, 2015, p. 393; Purzycki et al., 2018).

Results

Reproducing the focal results and support for the dual process model reported by Gervais et al. (2017) and Stagnaro et al. (2019), across all models, analytical thinking (CRT) was negatively related to religious belief controlling for political orientation (model summaries presented in the supplemental materials; Table S13). When holding political orientation constant at zero (i.e., amongst political centrists), these models predict varying magnitudes of belief reduction amongst those who respond correctly to *all* CRT items: 3.93 points out of 100 (Gervais et al. data; belief in God), 10.92 points (Stagnaro et al. data; belief in God), and 16.02 points (Stagnaro et al. data; supernatural belief).

As observed in Study 1, however, the estimated effect of CRT on belief was moderated by political orientation across models. The posterior distributions of regression coefficients at varied levels of political orientation are plotted in Figure 3 (and precise estimates presented in Table 3). In all three cases, we find that the association is more strongly negative in more liberal-leaning participants than in more conservative-leaning participants. That being said, the magnitude of the effect remains small and is less clearly differentiated in Gervais et al.’s (2017) more broadly cross-cultural dataset. Moreover, we again find only a slight indication of a reversal of the direction of the association in the conservative-leaning individuals as predicted by the expressive rationality model—and rather that the posterior distributions of the estimated association are more closely centered around zero. As in Study 1, this analysis provides evidence that the predictions of the dual process model of belief hold more for liberals than conservatives. And as in Study 1, although

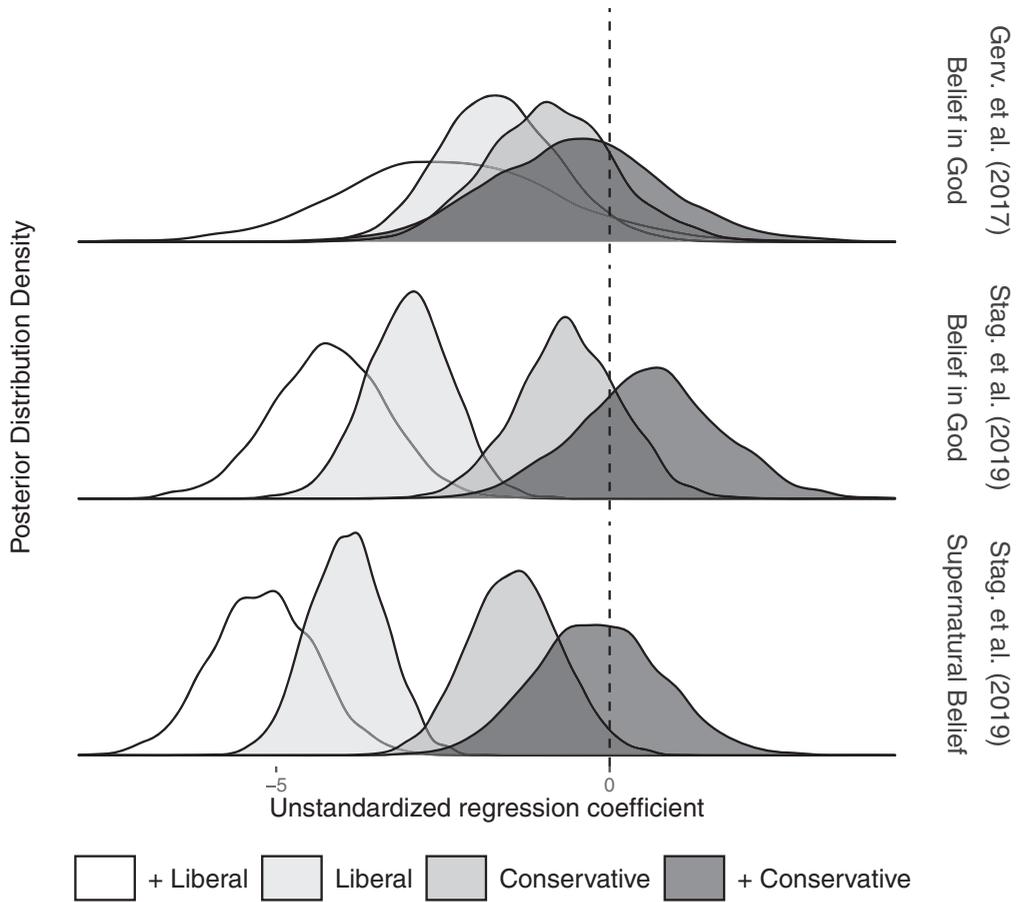


Figure 3. Posterior distributions of the estimated regression coefficients of analytical thinking predicting belief by political orientation.

Table 3. Estimated contributions of analytical thinking to belief by sample and political orientation.

Source	Outcome	Political orientation	b [95% HDI]	$p(b_{+LIB} < b_{+CON})$
Gervais et al. (2017)	Belief in God	+ Liberal	-2.41 [-5.31, 0.97]	.79
		Liberal	-1.65 [-3.32, 0.11]	
		Conservative	-0.89 [-2.81, 1.02]	
		+Conservative	-0.13 [-3.49, 3.26]	
Stagnaro et al. (2019)	Belief in God	+ Liberal	-4.21 [-5.90, -2.50]	.99
		Liberal	-3.01 [-4.28, -1.77]	
		Conservative	-0.61 [-2.17, 0.86]	
		+Conservative	0.59 [-1.53, 2.56]	
	Supernatural belief	+ Liberal	-5.19 [-6.64, -3.61]	.99
		Liberal	-3.93 [-5.02, -2.82]	
		Conservative	-1.42 [-2.72, -0.02]	
		+Conservative	-0.16 [-1.99, 1.73]	

Notes: Estimates are differences in belief (0–100) for each additional correct response on the CRT. The last column presents the posterior probability that the estimated association in the *most* liberal (“+LIB”) is more negative than in the *most* conservative (“+CON”).

we find no clear support for the expressive rationality models’ predicted *reversal* of the association in conservatives; we do find that the already small negative association approaches 0 in more conservative individuals.

Discussion

In Study 2, we further tested the predictions of the expressive rationality model of belief in two additional cross-cultural datasets. We find that in both of these datasets—the negative relationship between CRT and religious belief predicted by the dual process model of belief was to some extent stronger in increasingly liberal-leaning individuals. However, contrary to the prediction of the expressive rationality model, the association between analytic thinking and religious belief in conservative-leaning individuals was largely flat—it was not positive. These results provide further evidence that the contributions of CRT to religious belief can sometimes be just as “fickle” (Gervais et al., 2017) within cultures as they may be between them. While Stagnaro et al. (2019) demonstrated a negative relationship *controlling* for political orientation, our analyses demonstrate that the relationship is largely reduced to zero with greater political conservatism. And while this result does not provide strong evidence for the expressive rationality model of belief, in the general discussion we consider this evidence, in tandem with the results of Study 1, by returning to our focal question of “how” is analytical thinking related to religious and supernatural beliefs.

General discussion

How is analytical thinking related to religious belief? To answer this question, in two studies we tested competing predictions derived from three accounts about the contributions of cognitive style to religious belief (one of which, the counter-normative rationality model, went completely unsupported). As predicted by the dual process model of religious belief, we found that analytical thinking is robustly related to religious belief in the predicted negative direction, in large culturally diverse samples, for two distinct measures of analytic thinking (cognitive reflection and faith in intuition), and for several types of religious beliefs (i.e., belief in God, that religion is necessary for morality, in karma, in witchcraft). Nevertheless, the dual process model’s limitations in accounting for religious belief were apparent in the estimated small effect size and the consistently observed interaction of analytical thinking and political ideology, which is not obviously predicted by this model. And thus, the pattern of our results also fits to some extent with the predictions of an alternative account—the expressive rationality model of belief—that holds that analytical thinking is employed to sustain one’s already held commitments, particularly those emblematic of social identities. However, this model had its limitations too; from the perspective of the expressive rationality model, (1) the negative association between analytic thinking and religious belief should reverse for political conservatives, (2) the main association should disappear once the interaction with political ideology is taken into account, and (3) analytical thinking should only be associated with identity-relevant supernatural beliefs. These predictions received inconsistent support. The main effect often remained even after accounting for the interaction with political ideology; moreover, the predicted reversal (to a positive relationship between analytic thinking and religious/supernatural belief) for conservatives did not materialize in most of our samples. Instead, we consistently observed that rather than reversing in direction, the size of the association weakened or became zero among conservatives. And contrary to the expressive rationality model, we find that this weakening of the effect in more conservative participants compared to more liberal participants occurred in both identity-relevant (belief in God, belief that religion is necessary for morality) and *not*-obviously identity-relevant beliefs (belief in witchcraft in both Americans and Indians).

One way to interpret these results is to take them as evidence for a “weak” version of the expressive rationality model that makes the prediction that analytical thinking will only be negatively correlated with religious beliefs amongst more politically liberal individuals, while being largely unrelated to belief amongst more politically conservative individuals. But it is not directly obvious why identity-protective cognitions would be less involved in maintaining religious and supernatural beliefs in the typically more religious sub-samples of our datasets (i.e., conservative-leaning individuals). Another way to explain these results might be to make the prediction that if we had more data

from the *most* liberal and *most* conservative individuals, we might have observed stronger evidence for the predicted reversal and the spreading interaction. Testing this prediction is one clear way forward for research of this kind. But yet, an altogether different explanation arises from considering the relative contributions of “cognition” and “culture” in predicting religious and supernatural beliefs.

A recent review of the empirical evidence (White et al., 2021) and a pre-print of a study that employs a nationally representative sample of Americans (Gervais et al., 2019) provide evidence that analytical cognitive style is a robustly weaker predictor of religious and supernatural beliefs than is growing up with caregivers who consistently demonstrated their religious commitment (i.e., religious credibility enhancing displays; Lanman & Buhrmester, 2016). What our results might suggest is that high enough cultural exposure to religion—as might be more likely in more conservative individuals than in liberals—leaves little room for cognitive style to have sway over the extent to which one endorses religious and supernatural beliefs. This perhaps explains the fairly consistent reduction in the association between analytical thinking and belief in politically conservative individuals. If this is the case, then the dynamics at play might have little to do with identity-protective cognition; instead, political orientation in our datasets is perhaps acting as a proxy-measure for cultural exposure to religion. In support of this view, Gervais et al. (2019) found that analytical thinking only predicted supernatural beliefs in those with relatively lower cultural exposure to religion. That being said, this alternative explanation does little to account for the cases, particularly at the extremes of political orientation, in which some of our models do indeed predict patterns in line with the expressive rationality model.

Taken together, it is clear that neither the dual process nor the expressive rationality model can fully account for all of the observed data. And importantly, neither of them (as they are currently posited) seem fully equipped to deal with how intuition and/or analytical thinking may or may not be implicated in “religious and supernatural belief” (broadly construed) in a variety of different cultural contexts. Although it is the counter-normative rationality model that went entirely unsupported—it is the dual process model of belief, given its broad predictive potential, that requires the *most* re-calibration. The dual process model of belief as it is currently formulated provides no explanation for the observed within-sample heterogeneity in how the strength of the association between analytical thinking and beliefs depends on political orientation. And thus, it has the *most* difficulty accounting for some observations, like those reported here, that the relationship between cognitive style and belief is sometimes (though not always) moderated by political orientation. The evidence suggests, in part, the operation of motivated reasoning processes in justifying both believing and not believing. Importantly, the current analyses show that the dual process and expressive rationality models as applied to religious belief likely have independent explanatory value (despite their shortcomings) and are not necessarily incompatible theoretical accounts. The pattern of results is thus consistent with the idea that at least two independent, interacting psychological processes are at play, one guided by the intuitiveness of supernatural beliefs consistent with a dual process account, the other guided by motivated reasoning consistent with the expressive rationality account. And from what we have learned from other recent work in this area (Gervais et al., 2019), it is all together possible that the extent to which either or both of these processes contribute to belief may covary in meaningful ways with a third psychological mechanism—cultural learning driven by social exposure to religion.

Given the expressive rationality’s model explanatory power in other domains (e.g., climate change beliefs; Kahan et al., 2012), at least where it has been tested (i.e., in nationally representative samples of Americans)—it remains an open question, as to whether our results would look different with access to a broader, fully representative sample. Our results demonstrate some cross-culturally recurrent patterns in predicting diverse religious and supernatural beliefs. But of course, a clear way forward in unpacking the contributions of cognitive style to belief is to continue broadening the scope of these types of investigations, in more diverse cultures—but also more broadly within cultures. On this front, future work should broaden the scope of the content of examined supernatural beliefs to include those that might also be more representative of both liberals and conservatives in their

investigations of the cognitive mechanisms supporting supernatural beliefs. For example, belief in astrology, horoscopes, and the Tarot is high amongst North American youth, consistent with other secularized corners of the world (Beck, 2018; Pew Research Center, 2009)—and are similarly endorsed by liberals and conservatives (e.g., Lindgren, 2014).

Although the focal measures employed here are nearly ubiquitous in studies of the relationship between cognitive style and religious belief, they are certainly not without fault. It is important to note that some of the mismatches between the predictions and results reported here may result from measurement issues. For instance, given our research design, we cannot assess the reliability of single-item indicators of belief like those used here for belief in God (which also tend to be bimodally distributed). As a consequence, we concede that the models presented here may very well underestimate the magnitude of the relationship between analytical thinking and belief. However, even more reliable multi-item measures such as the often used Supernatural Belief Scale (Jong et al., 2013; used here in Study 2) still exhibit some degree of bimodality (see Figures S1 and S2). And thus, new measurement tools may provide further insight. That being said, supernatural beliefs may very well be bimodally distributed in many populations, and thus there may be even more to be gained in the application of novel modeling techniques to potentially capture with greater precision the correlates of religious and supernatural beliefs. Moreover, single-item measures of belief do not adequately capture the diversity in the kinds of gods (and other supernatural agents/forces) that people believe in across cultures, and the traits/qualities/capacities afforded to them (Johnson et al., 2019; Lang et al., 2019; Purzycki et al., 2016; Purzycki et al., 2018). In our data, we cannot identify, for example, which God Indian respondents (mostly Hindus) were considering at the time (though we note that belief in God is strongly endorsed by Hindu participants here and in previous research, e.g., Baimel, 2019; White et al., 2018). In so doing, research of this kind may otherwise be missing important pieces of the puzzle of understanding how belief covaries with psychological intuitions. In line with this view, recent evidence from samples of American Hindus suggests that intuitions are more supportive of belief in, for example, personal as opposed to abstract god concepts, even when they are more culturally normative (Baimel, 2019).

The three-item CRT employed across most of the studies here has more recently been expanded to seven items to increase reliability and relies less on participant's numerical intuitions (Thomson & Oppenheimer, 2016). And while the data from Stagnaro et al. (2019) as presented in Study 2 provide some evidence of consistency in results between the two versions, future work might benefit from the use of more diverse measures of cognitive style. That being said, we do report some consistency in effect sizes across two distinct measures of cognitive style (the CRT and the self-reported faith in intuition scale). Moreover, the single-item measure of political orientation employed in both of our studies could be elaborated into a more reliable and valid measure that also distinguishes between different types or aspects of political orientation (e.g., social vs. economic conservatism). More fine-grained measurements of political orientation may be particularly valuable for future cross-cultural research on this topic that considers more deeply the relationship between religious belief and political orientation (and types of conservatism) in diverse cultural settings.

Our results contribute to the growing literature examining the relative contributions of cognition and culture to the form and prevalence of religious beliefs around the world. Willard and Cingl (2017), for example, provide evidence that the contributions of cultural learning are substantially larger than that of cognitive processes in explaining between-country differences in the prevalence and strength of religious belief. Our results suggest that the contributions of cognition to belief might be greater when the cultural norms to hold certain beliefs are weak (i.e., commitment to religious beliefs in liberals as compared to conservatives). This interpretation fits well with previous work that demonstrates that intuitively supported cognitive biases are more strongly related to the endorsement of paranormal beliefs than the more culturally constrained belief in God (Willard & Norenzayan, 2013). Weighing the relative contributions of cognitive processes, motivational factors, and cultural learning is essential in broadening our understanding of what supports the

world's "theodiversity" (Norenzayan, 2016); and our results also demonstrate that there may be even more to be gained from considering how cognitive processes *interact* with social and cultural factors in the maintenance of religious beliefs (e.g., see Purzycki & McNamara, 2016). This is an important future direction for the cultural and cognitive sciences of religion.

Notes

1. Moreover, the entire philosophical tradition of natural theology has aimed at providing demonstrative arguments to prove God's existence and thus license great religious belief in the face of skepticism (Chignell & Pereboom, 2020).
2. The Indian participants in Study 1 were roughly 75% Hindu (the rest of participants were mostly Christian or Muslim); and although karmic beliefs are more strongly endorsed by Indian Hindus than other Indian sub-populations, they are still commonly endorsed by Indian Christians and Muslims (White et al., 2018).
3. These are the same two cases in which LOO model evaluation indicated no evidence for difference in predictive performance between regressions with and without the conservatism by analytical cognitive style interactions.

Author contributions

A.B. assembled the relevant datasets, conducted all analyses and wrote the paper with C.W., H.S., and A.N.

Disclosure statement

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ORCID

Adam Baimel  <http://orcid.org/0000-0002-2629-7952>

Cindel J. M. White  <http://orcid.org/0000-0001-6050-2449>

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