

# Breaches of Trust Change the Content and Structure of Religious Appeals

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**Abstract:** Considerable work suggests that social and environmental pressures can influence religious commitment, the content of beliefs, and features of ritual. Some ecologically minded theories of religion posit that cross-cultural variation in beliefs and practices can be partly explained by their utility in addressing persistent threats to cooperation and coordination. However, little experimental work has assessed whether or not socioecological pressures can generate systematic variation in the content and structure of specific beliefs. Here, we assess the causal pathway between social ecology and beliefs by experimentally examining whether or not the content of freely elicited beliefs about God's concerns change because of breaches of trust. We find that riskily investing in others and receiving no return in an economic Trust Game experiment increases the chances of claiming that greed angers God. These results suggest that religious cognition flexibly attends to social ecology and can therefore plausibly evolve in ways that address breaches in cooperative pursuits.

**Keywords:** gods' minds, economic games, trust, cognitive anthropology, experimental economics

## 1. Introduction

### 1.1. Evolution of religious systems

People everywhere face threats to cooperation, coordination, and the interpersonal trust that maintains them (Cronk and Leech 2013). The intensity and context-dependent character of these threats to fitness-enhancing social relationships vary within and across populations, and human beings adaptively respond to such threats with cultural information (Henrich et al. 2004). One such adaptive system is religion (Alcorta and Sosis 2005; Purzycki and Sosis 2013; Sosis 2005); with looming threats of supernatural punishment (Johnson 2015; Schloss and Murray 2011) and social bonding through trust-inducing rituals (Johansson-Stenman, Mahmud,

and Martinsson 2009; Sosis 2005), religion may reduce costly social encounters. Indeed, many have addressed rituals' (Johansson-Stenman, Mahmud, and Martinsson 2009; Soler 2012; Sosis and Bressler 2003; Power 2017) and beliefs' (Johnson 2005; Purzycki et al. 2016; Shariff and Norenzayan 2007) contributions to cooperation.

Yet, threats to or breaches in cooperative relationships vary cross-culturally, so we should expect to see a relationship between religious beliefs, practices, and these threats. Indeed, there is considerable ethnographic and cross-cultural evidence suggesting that religion both conforms and produces measureable benefits in response to locally specific challenges to social life (Reynolds and Tanner 1995; Wilson 2002). Facets of religion have been shown to: increase paternity certainty (Strassmann et al. 2012), contribute to higher caloric returns (Bird et al. 2016; Bliege Bird et al. 2013), curb competition with livestock (Rappaport 2000), mediate water distribution (Lansing 2007), and localize male competition (Shaver and Sosis 2014). The heightened temptation to defect on cooperative relationships induced during times of war predicts ritual intensity (Sosis, Kress, and Boster 2007) and a large literature finds that beliefs in "moralistic high gods" are associated with factors such as social complexity, resource scarcity, and animal husbandry (Botero et al. 2014; Johnson 2005; Peoples and Marlowe 2012; Roes and Raymond 2003; Swanson 1960; Wallace 1966). Religious faith appears to increase as a response to natural disasters (Sibley and Bulbulia 2012; Stephens et al. 2013) and exposure to war (Henrich et al. 2019), suggesting that people are increasingly attracted to the benefits that religious communities provide under dire conditions.

Despite this knowledge, we have little in the way of an experimental treatment that examines the proximate generation of variation in beliefs and practices in ways that address salient problems in social ecologies. Can threats to sociality contribute to systematic changes in beliefs? Is religious cognition vigilant and flexible enough to respond to such threats? Here, we initiate this inquiry with a study designed to examine whether or not threats to mutualistic social relationships built on trust can contribute to the evolution of religious beliefs and appeals in the form of gods' concerns.

## 1.2. Social ecology and gods' minds

Like religious practices, gods' culturally specified concerns also revolve around a surprisingly narrow set of human behaviors, all of which have practical utilities (see Boehm 2008; Purzycki and McNamara 2016; Purzycki and Sosis 2011). However, little is known about the cognitive underpinnings of how such beliefs grow to conform to social ecologies<sup>1</sup>. There is some evidence indicating that beliefs about gods' concerns can be flexibly and synchronically directed towards social ends with potential for diachronic stability (see Henrich et al. 2019; Sibley and Bulbulia 2012 for results pertaining to general religiosity). For example, in Papua New Guinea, Barker

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<sup>1</sup> The cognitive processes involved in the representation of other minds is central to our thinking about gods (Barrett 2004; Boyer 2001; Guthrie 1980), and are compelling notions because gods' minds are often represented as free from some of the cognitive (e.g., omniscience) and physical (e.g., incorporeal) limitations of human agents (Barrett, Richert, and Driesenga 2001; Lane, Wellman, and Evans 2014, 2012; Heiphetz et al. 2016). Gods' powers are thought to extend far beyond humans' abilities (e.g., changing the weather and punishing people in supernatural ways) therefore represented as agents who have the power to affect people in important ways. Gods' interventions are rendered especially powerful as people also infer that they have access to important information about us (Boyer 2001; Garcia 2015; Johnson 2015; Purzycki et al. 2012; Tremlin 2006; Pyysiäinen 2009).

(2008) observed how specific religious appeals between two feuding communities immediately arose after a flood. Members of each community blamed the sorcerers of the other for the malevolent deployment of spirits over the “long-standing feud” or planting gardens on “disputed land.” Others suggested that God was punishing them for “lax church attendance.” In general, these groups “are most urgently concerned with what spirit encounters and attacks reveal about their moral condition, that is, the aspects of their lives they actually *can* control” (122-125). Note, too, that “The trigger for a sorcery attack in almost all cases is a breach of morality, a denial of reciprocal balance” (130). In the face of uncontrollable forces of nature and self-interested violations of normative behavior, people will appeal to the supernatural in fairly calculated ways; magical retaliation *and* church attendance are social actions that bring people together.

Compare this to quantitative evidence from the Tyva Republic of Siberia, where cognition and explicit beliefs about local “spirit-masters” minds are strongly associated with social ecology and the natural environment. For example, Tyvans anchor their reasoning about what spirits know to spirits’ areas of governance (Purzycki 2011, 2013b). People claim spirits are primarily angered by sullyng exploitable resources and pleased by ritual offerings conducted at these resources and on borders of herding territories (Purzycki 2016). Tyvans appear to increasingly associate pandemic alcoholism with what angers both spirit-masters and Buddha (Purzycki and Holland in press). With respect to how some of this variation mediates relationships, there is evidence that the more individuals claim local spirits know, the more likely they are to exhibit parochial favoritism (Purzycki and Kulundary 2018; cf. McNamara, Norenzayan, and Henrich 2016), and that participation in rituals devoted to spirit-masters increases perceived generalized trustworthiness (Purzycki and Arakchaa 2013).

Indeed, anthropology (and other fields inspired by its efforts) has long appreciated that components of religious beliefs and behaviors conform to socioecological pressures (Reynolds and Tanner 1995). Mitigating these pressures typically requires coordinated effort, and appeals to punitive gods might point to behaviors that can minimize these pressures’ effects and/or bring people together to overcome challenges to individual wellbeing. However, to the best of our knowledge, no experimental evidence exists that manipulates social conditions to examine the genesis of changes in the content and structure of religious beliefs. If appeals to gods’ concerns are effective means to induce others’ mutualistic behaviors, then models of gods’ minds should change in response to costly breaches of social norms. In other words, particular challenges to cooperation and coordination should serve as inputs to religious expression.

## 2. Study

### 2.1. Methods

#### 2.1.1. Trust game

To test the prediction that beliefs about gods’ minds change in response to threats to cooperation and coordination, we piloted a study that manipulated outcomes in a modified Trust Game (Anderson, Mellor, and Milyo 2010; Berg, Dickhaut, and McCabe 1995; Brühlhart and Usunier 2012; Bowles and Gintis 2004; Cronk 2007; Johnson and Mislin 2011).

In a standard Trust Game, Player A receives a sum of money, then decides how much, if any, of this amount to send to Player B. As understood by both players, the amount sent is then

tripled and passed to Player B, who decides how much, if any, of this new amount to return to Player A. As Player B can keep all of the money, Player A's decision has some risk and therefore represents an index of trust. For example, if an initial sum is \$10, Player A can choose to keep this smaller--but guaranteed--amount (indicating low trust), or can send the full amount in hopes of getting a larger return (high trust). Player B's return amount is a measure of trustworthiness. Here Player B can make either a selfish choice (e.g., defect and keep the full amount of \$30), a cooperative choice (e.g., return \$15, or split the total), or an altruistic choice (e.g., return the full amount of \$30). Usually, investments and returns are dependent variables, and researchers use target variables of interest to predict game outcomes. We used this game due its practical utility—it is a simple two-person game—and the general importance of trust in facilitating reliable cooperative ventures.

In order to simulate and manipulate variation in costly social interactions, our study applied two major modifications to the Trust Game. First, rather than use beliefs to predict game outcome, we used game outcomes as independent variables to predict beliefs. We measured beliefs with a free-list task about what angers God (see below). The second modification to standard Trust games is that we manipulated the game play of Players B. Here, participants were all Player A and randomly assigned to a smaller group of Players B to generate one of the following four conditions<sup>2</sup>:

1. **Control:** a control condition that had no Trust Game;
2. **Defect:** participants first sent all of their money, learned Player B returned nothing, then completed the free-list task;
3. **Split:** participants first sent all of their money, received half of the tripled amount, then completed the free-list task;
4. **Delay:** participants played the Trust Game but did not know the outcome of the game until *after* they completed the free-list task where they received half of the tripled amount.

Using Player B outcomes as experimental conditions, we simulate variation in costly/profitable social relationships in order to determine their effects on religious appeals in the form of expressed beliefs about what angers God.

### 2.1.2. God's concerns

To measure religious appeals, we used a free-list task (Quinlan 2005) that instructed participants to enter at least ten things (1-2 words each) they think displeases God in a free-response box. Free-listing gods' concerns was successfully employed in a variety of field sites from around the world (Purzycki et al. 2016) and avoids forced-choice or scale-based items that may suffer from ceiling effects with participants in the traditions with morally concerned gods. It also has the advantage of being cross-culturally useful among innumerate and/or non-literate

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<sup>2</sup>For payment purposes and to make sure the decisions in the main study were real, we recruited a smaller set of individuals as Players B later. We recruited these individuals based on their demographics, such that they matched the reported partner demographics in the main study (e.g., 31 years old, Caucasian, American, and who represented the needed religious categories). Once we found a sufficient set of participants who met our criteria, they made a Player B decision (all receiving the information that "Player A has sent the full endowment" without noting the amount). As soon the individuals made a "send half" or "keep all" decision (presented dichotomously), they were matched with all the relevant participants and paid based on their decision. Thus, many individuals in the Player A role were actually matched with one individual representing Player B.

populations, a future goal of this project. Participants had as much time as needed to think of as many items as they could. Using this method, we can calculate Smith's *S*, a value that increases as a function of an item's ubiquity in a sample and position in individual lists (Smith 1993; Sutrop 2001; Thompson and Juan 2006). As such, we can attend to the content, structure, and prevalence of beliefs about gods' concerns.

Prior to analyses, we targeted a set of "greed" items as our outcome variable<sup>3</sup>. We reasoned that "greed" was the most appropriate concept to focus on as a response to the Defect condition. We also examined a set of nine other items included in the lists that we thought were semantically related to greed: dishonesty, theft, selfishness, love of money, materialism, unfairness, untrusting, cheating, and exploitation. Including "greed," we refer to these ten items as our "greed set."

### 2.1.3. Demographics and social data

We collected a range of sociodemographic data. Those considered here were:

- **age:** continuous measure
- **sex:** 0 = female; 1 = male
- **income:** (1) under 5k, (2) 5k-10k, (3) 10k-15k, (4) 15k-25k, (5) 25k-35k, (6) 35k-50k, (7) 50k-65k, (8) 65k-80k, (9) 80k-100k, (10) over 100k

To account for self-reported religiosity, we used the following measures:

- **religious service:** how often they attend religious service, (1) never - (5) only on holidays - (10) daily
- **prayer:** how often they pray, (1) never - (10) very regular
- **religious material engagement:** how often they engage with religious material (1) never - (10) very regular
- **strength of belief:** how strongly they believe in god (1) do not believe - (10) very confident
- **religious teaching:** how strongly they believe in their religious teaching (1) not at all - (10) very much

This scale had high internal consistency ( $M = 6.28$ ,  $SD = 2.27$ ,  $\alpha = .87$ ). We therefore created a composite measure of religiosity using the mean of these items for each individual (see supplements for further discussion).

### 2.1.4. Procedure

We conducted this study using Amazon Mechanical Turk (Horton, Rand, and Zeckhauser 2011; mTurk henceforth). We advertised the study as taking approximately 9 minutes to complete. The actual average time taken to complete was 12.9 minutes. All participants began by reading a short introduction. To check for the potential framing effects of a study about religion, we varied the introduction:

- In this HIT [Human Intelligence Task] we are interested in people's religious beliefs, ideas, attitudes and behaviors

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<sup>3</sup> By way of preregistration, our project's grant proposal listed the first hypothesis as such: "God's concerns for dishonesty, greed, or breaches of trust will be more salient and frequently reported after getting no money returned in a trust game."

- In this HIT we are interested in people's beliefs, ideas, attitudes and behaviors<sup>4</sup>.

This was followed by participants entering their demographic information (e.g., including sex, age, education, ethnicity, nationality, first language, income, social political orientation, fiscal political orientation, and religious affiliation). Participants were then randomly assigned to one of the aforementioned four conditions. All scales and a full walkthrough of the study interface can be found in supplementary materials.

For the conditions including the Trust Game (Defect, Split, and Delay), participants first finished the demographic survey and continued on to the Trust Game instructions. These instructions explained that participants were going to be randomly assigned to the role of Player A, that another individual would be assigned to Player B, the initial endowment amount (\$0.50), the high multiplier (4x)<sup>5</sup>, and both players' option sets. Participants then answered four comprehension questions asking about the payoff structure of the game<sup>6</sup>. To increase perceived authenticity of Player B, as well as communicate that Player B was a religious ingroup member<sup>7</sup>, participants were told they would share some information about each other before making the Trust Game decision (Bulbulia and Mahoney 2008; Stagnaro, Dunham, and Rand 2018).

Participants were first presented with their own reported age, ethnicity, nationality, and religious belief, and told to check for errors. They then submitted their information to see the matched information for Player B. Participants continued on to see Player B's information, using the most common age, ethnicity and nationality on MTurk for the first three categories, followed by the participant's *own* religious category in order to avoid any outgroup effects:

*The person in role B is 31 years old. They have identified their ethnicity as Caucasian and nationality as American. They also describe themselves as [participant's religious affiliation].*

This information was presented on the same screen as the dichotomous Trust Game decision: *Don't send \$0.50 / Send \$0.50* (for precedent using dichotomous options, see Jordan, Hoffman, Bloom, et al. 2016; Jordan, Hoffman, Nowak, et al. 2016). As our primary target of inference was the difference in beliefs between those not engaging in a risky behavior and those who were, we removed all participants ( $n = 23$ ) who opted to keep the initial endowment thereby avoiding engaging in a trusting relationship. Those in the Defect and Split conditions conducted free-list tasks immediately after they saw Player B's decision. In the Defect condition (i.e., the greedy outcome), Player B chose to keep the quadrupled amount (\$2.00) while in the Split condition, Player B split the amount. Those in the Delay condition then continued with the study "while Player B makes their decision." They completed the free-list task before knowing

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<sup>4</sup> We found no effect of this variable on any of the outcomes. We nevertheless retain them in all models as a necessary control.

<sup>5</sup> We used this higher multiplier to both increase the number of participants who would choose the "send" option as well as increase the frustration with receiving no return.

<sup>6</sup> To ensure comprehension and prevent attrition, we gave participants two chances to answer the comprehension questions correctly.

<sup>7</sup> This was necessary to ensure participants were both familiar with the religious expectations, and extended them out to Player B without any confounding factors for cross-tradition relations.

Player B's decision. Upon finishing the study, participants submitted a confirmation code to receive payment.

## 2.2. Hypotheses, model, and analysis

Our focal prediction was that people in the Defect condition were more likely to associate greed with God's anger than those in the Control, Split, and Delay conditions; costly breaches of cooperation will trigger the generation of beliefs about what angers God more than the other conditions. The predictions regarding the Split and Delay conditions are less straightforward, however. We initially reasoned that the Split condition—where Players B split the endowment—should have little to no comparable effect on listing greed items because negative outcomes are more likely to induce changes in conceptions of what angers God. However, prior to data collection, we subsequently questioned this as a split outcome could *increase* the chances of listing “greed” as it would resemble a justification of others' proper behavior, particularly as participants played with people of the same religion (see below). We also predicted that participants in the Delay condition would also be more likely to appeal to God's concerns of greed than participants in the Control condition insofar as a delayed outcome recruits the kind of psychology engaged when trying to moderate others' behavior *in situ*. In other words, Players A might anticipate a breach in trust (but nevertheless take the risk) and therefore modify appeals to gods in order to ensure an equitable outcome. A null outcome would not rule this out, however, as participants had no way of communicating with Player B and knowing this fact may simply override impulses. We return to these issues in the discussion section.

As the data in our dependent variables were all dichotomous (1 = item listed; 0 = item not listed), our full models took the general form of:

$$\begin{aligned}y_i &\sim \text{Binomial}(1, p_i) \\ \text{logit}(p_i) &= \alpha_{i,j} + \beta_i X_i \\ X_i &= \text{condition} + \text{religiosity} + \text{sex} + \text{age} + \text{income} + \text{framing} \\ \alpha_{i,j} &\sim \text{Cauchy}(0, 2) \\ \beta_i &\sim \text{Normal}(0, 1)\end{aligned}$$

where we predict the probability,  $p_i$ , of listing a binomially distributed item,  $y_i$ . We use a logit link function to define  $p_i$  in two ways.  $\beta_i X_i$  denotes simple, individual-level effects for mean-centered age, religiosity, religious framing, and the condition. As we used a continuous categorical scale for income, we modelled its effects monotonically. In the main text, we present two models. One predicts listing an item in the “greed set” (i.e., the 10 items including “greed” and those items associated with it). The “greed set” model treats participant as a varying intercept ( $\alpha_i$ ). Our “greed” model predicts only the probability of listing “greed” (i.e., includes only  $\alpha_i$ ). For both models, the reference group for condition was the Control group. We used weakly informative priors for all parameters. As diagnostics, we checked  $\hat{R}$  values (all  $< 1.01$ ) and effective samples across models which all mixed well.

We performed all analyses in R V3.4.3 (R Core Team 2016). We first created a participant-by-item matrix of the free-list data using the AnthroTools package V0.8 (Jamieson-



Lane and Purzycki 2016; Purzycki and Jamieson-Lane 2017). This package surveys the entire set of listed items, codes whether or not participants listed any of them, and calculates salience by item and across conditions. We used the brms V2.2 (Bürkner 2017) package for all main regression analyses. We provide all data, a codebook, supplementary analyses, a walkthrough of the online experimental interface, and analytical script code at <https://github.com/bgpurzycki/Social-Ecology-of-Gods-Minds>.

## 2.3. Participants

To ensure consistency across participants, we considered only participants who reported a religious affiliation and believed in God. After removing those who kept the initial endowment, those who took the survey more than once, individuals who failed quality checks, did not do the free-list task, and non-religious individuals ( $n = 181$ ), we retained 279 participants across four conditions for this data set. Table 1 reports the details of our focal variables across the four conditions. All participants were compensated a flat rate show up fee (\$0.40) for participation. Additionally, only participants who correctly answered the comprehension questions were eligible to receive the game return (\$1.00, \$0.50, or \$0.00, depending on condition).

**Table 1 | Basic demographics across conditions.** Means (*standard deviations*). \*Denotes ordered categorical variables.

Condition	N	Females	Christians	Muslims	Jews	Buddhists	Age	Religiosity	Education*	Income*	<i>n</i> list greed (%) [S]
Control	74	50	71	1	2	0	39.82 (14.08)	6.33 (2.31)	4.49 (1.10)	5.62 (2.45)	24 (32%) [0.18]
Defect	64	39	56	2	3	3	40.33 (11.27)	6.02 (2.17)	4.69 (1.04)	6.08 (2.16)	31 (48%) [0.26]
Split	67	39	63	0	0	4	39.72 (12.91)	6.36 (2.43)	4.42 (1.34)	5.64 (2.55)	23 (34%) [0.19]
Delay	74	44	68	0	2	4	41.15 (13.11)	6.38 (2.18)	4.55 (1.09)	5.68 (2.27)	31 (42%) [0.25]

## 2.4. Results

### 2.4.1. Structure of beliefs

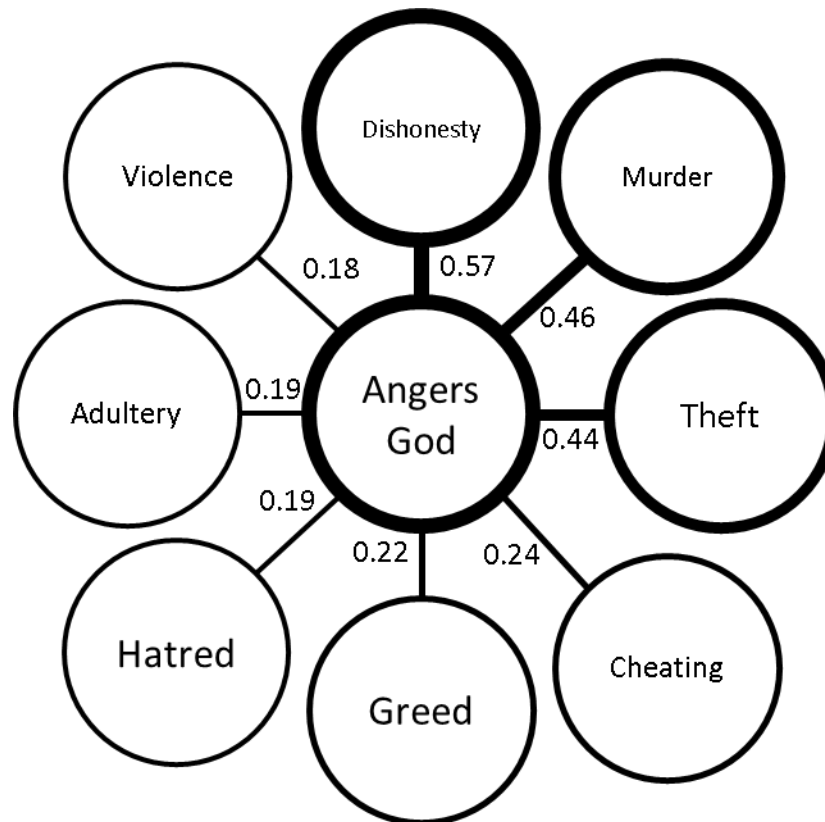
Figure 1 details the cultural model of what angers God across all four conditions. The most salient items revolve around lying, murder, theft, and other breaches of morality. After violence were “sin” ( $S = 0.12$ ), “cruelty” (0.12), and “selfishness” ( $S = 0.10$ ). All other items listed had an  $S < 0.10$ .

To assess the construct validity of our “greed set,” we took our pre-selected items and factor analyzed them using McDonald’s  $\omega$  factor analysis in R’s psych package (Revelle 2014). Overall, these items were not strongly listed together ( $\alpha = 0.22$ , 95% CI = [0.10, 0.35]). This is sensible given the nature of the task; we were not asking participants to rate items on the same scale. Rather, this was an interrogation of a relatively broad conceptual domain that we capped at 10. Given the serially chunked nature of representational models (Mandler 1967), there nevertheless was some structure to responses. When participants list “cheating”, they are also likely to list “dishonesty” and “theft.” Similarly, participants also listed “materialism” and “love



of money” together. Likely, due to its variation across experimental conditions (see results), “greed” constituted its own factor. In summary, our target items were not strongly indicative of a latent factor. We nevertheless modelled the likelihood of listing these items in some of our model specifications as we originally intended.

**Figure 1 | Representational model of what angers God.** Image includes eight-most salient items. Most salient item is at the top, with salience decreasing clockwise. Connection and circle weights indicate Smith’s S. Note that this data is from the entire sample ( $n = 279$ ). See Tables S2-S3 for summary statistics.



#### 2.4.2. Evolution of beliefs

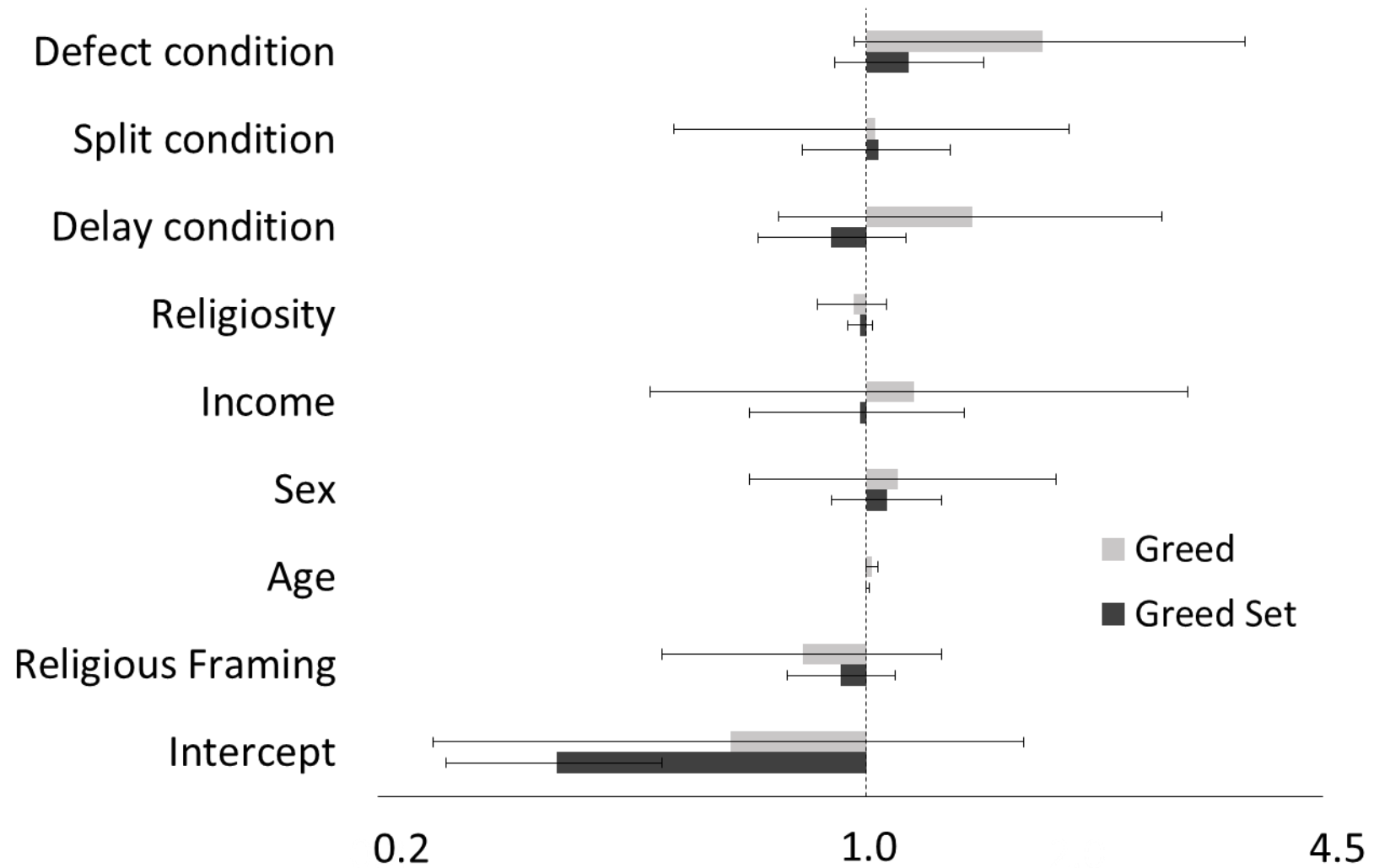
Table 2 reports the regression results. Figure 2 illustrates focal effects. Holding all other factors constant, the model estimates the chances of participants in the control condition listing greed was 39% (95% CI = 19-63%; the logistic transform of the intercept  $\beta = -0.45$  and 95% credibility intervals, [-1.44, 0.52]). Consistent with our predictions, participants who received no return in the Trust Game (Defect condition) were more likely to list both greed and greed set items. Being in the Defect condition increases the chances of listing greed to 64% (95% CI = 49-78%), a 25% chance increase from the control condition. In fact, being in the Defect condition was the most reliable predictor of listing greed. The greed set model estimated a 26% chance of listing greed set items (95% CI = [20-34%]) in the control condition with the Defect condition increasing the chances of listing greed set items by 27% (54%, 95% CI = [47-60%]). Both sets of models show that the bulk of the probability mass of the intervals are in the positive direction.

Across both models, the Split condition showed no major effect in either direction; there was a 51% chance of listing greed (95% CI = [35-66%]) and greed set items (95% CI = [45-57%]), thus effectively random. The Delay condition induced a 59% chance of listing greed (95% CI = [43-73%]); a slight—but imprecisely estimated—increase, but showed no overall effect in the probability of listing greed set items (47%, 95% CI = [41-53%]).

Religiosity showed a slight decrease in listing greed, suggesting that more dedicated believers are less resilient to change and/or less likely to list greed or greed set items. The religious framing showed weak and imprecise signs of reducing the chances of listing greed set items as well. Sex and income showed no strong association with listing greed or greed set items and while positive, the association between age and listing greed or greed set items was negligible.

**Table 2 | Odds ratios (exponentiated estimates) and 95% credibility intervals for main Greed and Greed Set Models.**

	<b>Greed</b>	<b>Greed Set</b>
<b>Defect condition</b>	1.79 [0.96, 3.48]	1.15 [0.90, 1.47]
<b>Split condition</b>	1.03 [0.53, 1.95]	1.04 [0.81, 1.32]
<b>Delay condition</b>	1.42 [0.75, 2.65]	0.89 [0.70, 1.14]
<b>Religiosity</b>	0.96 [0.85, 1.07]	0.98 [0.94, 1.02]
<b>Sex (1 = male)</b>	1.11 [0.68, 1.87]	1.07 [0.89, 1.28]
<b>Age (centered)</b>	1.02 [1.00, 1.04]	1.00 [1.00, 1.01]
<b>Income</b>	1.17 [0.49, 2.88]	0.98 [0.68, 1.38]
<b>Religious Framing</b>	0.81 [0.51, 1.28]	0.92 [0.77, 1.10]
<b>Intercept</b>	0.64 [0.24, 1.68]	0.36 [0.25, 0.51]
<b>Model name in R script</b>	bfull6	lbfull6



**Figure 2 | Odds ratio plot of main results in Table 2.** Error bars are exponentiated 95% credibility intervals. Histogram endpoints are the odds ratios of listing greed or greed set items. X-axis is on a logarithmic scale.

### 3. Discussion

While many have suggested that religion contributes to cooperation in a variety of ways, few have demonstrated a causal relationship between breaches of cooperative behaviors and individual religious appeals. Our results indicate the presence of a cognitive system that attends to important information about the socioecological environment and subsequently alters the content and structure of religious beliefs and appeals. Specifically, breaches in trust increase the chances that people associate greed with what angers God. However, waiting for an interaction's outcome also appears to have a slight effect on appealing to God's concern of greed. This suggests that the kinds of violations to mutualistic relationships plausibly generates the variation we see in religious beliefs around the world. Of course, these beliefs can then be readily transmitted along many routes and subject to processes of cultural evolution (Kendal et al. in press).

There were also some immediate limitations in the design of our study. Recall that we had four conditions: the control and three experimental conditions including no return, an even split, and a delayed response. As mentioned earlier, it is difficult to rule out some conflicting interpretations with the Split and Delay conditions. For instance, getting a split return in the game might have increased the chances of listing greed because it confirmed the appropriateness of the return; people might be more inclined to list greed because people were *not* greedy. In the Delay condition, we found greater chances of listing "greed" than in the Control condition; we predicted that this would be the case as it simulates religious appeals; people are more likely to claim greed angers God as a way to influence others' behavior before it happens (even though there was no way participants could do this). However, the Delay condition appears to have *decreased* the chances of listing greed set items overall, suggesting that more precise assessments of cross-condition changes to specific items is in order.

Another potential issue is that while the game ostensibly measures "trust", it is unclear that participants recognized it as such. Rather, participants appear to have interpreted Player B's actions as just greedy rather than untrustworthy. This does not necessarily create problems with our hypotheses as much as shed light on potential problems with what these games actually measure from a cognitive perspective. Brühlhart and Usunier (2012) claim to rule out "altruism" as a motivation by finding no differences in Players' A initial transfers when they know that Players B had either no show-up fee or show-up fees of 10 or 20 Swiss francs. They reason that if participants are motivated by things other than trust (e.g., altruism), they would be less likely to risk their initial endowments to people who already have sufficient funds. In our case, we simply used the method as a way to examine its influence on beliefs rather than test whether or not the games are cognized as the dilemmas their developers claim they measure. It is not unreasonable to assume that Player A recognized this as a matter of trust since they knew that giving their initial endowment could double if Player B was trustworthy. If so, it may just mean that shifts in the specific appeals to god's mind are judgments of locally salient behaviors rather than assessments of threats to relationships more generally.

Notably, religiosity negatively predicted listing greed set items; the more religious people were, the *less* likely they were to list greed items. We are unsure as to why people who are more religious are less inclined to list such things. One possibility is that it may have been due to "prosperity theology" (Biema and Chu 2006) and/or some strains of conservative

Christian fundamentalism. As discussed in the supplements, our religiosity scale negatively predicted political liberalism; religious conservatives might be less inclined to claim that greed angers God because they might hold withholding resources as virtuous. However, replacing the religiosity scale with the liberalism counterpart yielded no comparable effect, suggesting that further consideration of the complex relationship between demography, religiosity, personal politics, and free-list outcome is the next step before committing to further model development.

While people around the world appear to believe that their gods care about things like resource management, social etiquette, and ritual (Purzycki and McNamara 2016), the god we used here was the Abrahamic deity, a god prototypically concerned with morality, models of which include things like “greed” and “selfishness” (Purzycki et al. 2018). Our experimental condition(s) are likely to have only increased such items’ salience rather than introduced relatively new concerns to a deity. If we conducted a study among traditional populations where a deity is primarily concerned with, for example, conservation practices, would we find the same effect? Assessing this would be a much stronger test of our method and theory. Some evidence suggests that an effect isn’t implausible; in cases like the Tyva Republic, people explicitly claim their deities care primarily about ritual and keeping sacred places free from litter (Purzycki 2016). However, people nevertheless associate them with moral concern when directly asked if spirits care about moral things and a small minority of participants associate spirits with concerns of alcohol abuse, a relatively new and devastating social problem there (Purzycki 2011, 2013b).

In Taiwan, Mazu, the goddess of the sea, has become the “anti-nuclear power goddess” in part due to increased nuclear energy development and anti-nuclear power activists’ disillusionment with party politics (Shih 2012). Another example might be the burgeoning field of “eco-theology,” a movement that is reframing the Abrahamic traditions as environmentally friendly (Chaplin 2016; Purzycki and McNamara 2016; Sponsel 2014; Taylor 2010; White 1967). This appears to be in response to climate change and growing extinction rates. In our sample, 14 individuals (5%) listed a variant of “environmental destruction” among the ten listed items (two listed it after their tenth item). While these items were rarely listed ( $S = 0.02$ ), for those who did, their average salience was relatively high (0.46). In sum, the potential for using this paradigm in another context may yield similar results. However, there are some immediately implausible scenarios. If, for example, in a context where advantageous ritual participation temporally fluctuates with temptation to defect on cooperative relationships, it is unlikely that this synchronic method could induce hints of such a diachronic process. More convincing results in an experimental economic game paradigm might come from using multiple iterations of the same game and/or different games to simulate different “environments.” Sustained problems are more likely going to produce sustained and perhaps stronger shifts in belief sets and iterated games afford this possibility. Different environments might be simulated by other games such as the Third-Party Punishment Game (Fehr and Fischbacher 2004). In this game, there are three players (Players 1-3). Player 1 is given some money and told to allocate money to Player 2. Player 3 is allowed to use their own endowments to pay to punish Player 1’s decision. Doing so would take money away from Player 1 and redistribute it to Player 2. In other words, Player 3 can sacrifice his or her own earnings to punish someone. Even in cases where people allocate money equally or generously to Player 2, Player 3 can still punish players for

their decisions. Under such conditions, the salience and frequency of listing God's concerns of injustice and unfairness might increase because of corresponding third-party actions. However, if people do, in fact, outsource punishment to gods (Laurin, et al. 2012), the presence of secular punishment may offset the likelihood of altering god's concerns.

In summary, breaches of trust can contribute to change in the content and structure of beliefs about gods' concerns. If appealing to what gods want is a useful way to curb others' self-interested behavior in ways that increase our own gains, it makes sense that human cognition would be equipped with devices that would rapidly associate problems with dominant, punitive spiritual agents (Johnson 2015). These results suggest just how significant the interactions between our cognitive systems and the socioecological climate are in accounting for the variation we see in human religious systems. In our view, attending to how human cognition and culture respond to socioecological inputs remains an area in need of considerably more attention.

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