

Teleological Explanations of Nature Relate to Supernatural Agent Detection

Among Theists and Atheists

by

Matthew Scott

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Graduate Supervisory Committee:

Adam B. Cohen, Chair

D. Vaughn Becker

Gene A. Brewer

Douglas T. Kenrick

ARIZONA STATE UNIVERSITY

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## ABSTRACT

Humans are biased toward teleological explanations of natural phenomena. The promiscuous teleology account posits that this proclivity is rooted in the detection of supernatural agency behind the design of the natural world. This idea is supported by numerous positive correlations of religious belief and agreement with teleological explanations of natural phenomena, but it is challenged by findings that non-believers often agree with them as well, suggesting the need for an adjudicating experiment. The current experiment tested whether considering similar teleological explanations of nature causes explicitly theistic and atheistic people to think about God, which would suggest that the teleological bias has roots in agency detection. Participants ( $N = 608$ ) were randomly assigned to consider teleological explanations of either human-caused phenomena or natural phenomena, with the main prediction that considering the natural item set would make theists relatively faster to categorize God as real but make atheists relatively slower to categorize God as imaginary. The data did support this hypothesis, suggesting that people across the theistic belief spectrum automatically think of God when thinking about nature's purpose, and thus the teleological bias might be rooted in the detection of supernatural agency. Implications for theories of teleology, study limitations, and potential future directions are discussed.

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## **Teleological Explanations of Nature Relate to Supernatural Agent Detection Among Theists and Atheists**

Human beings instinctively believe that natural phenomena exist for a purpose. By the time children can understand competing causal explanations for nature, they vastly prefer teleological accounts to purely mechanistic ones, whether or not the target is a living thing (Kelemen, 1999, 2004; Kelemen & DiYanni, 2005). Cognitive and educational development lead to a more selective teleological stance, but experiments show that the promiscuous teleological stance of childhood remains a highly available explanatory preference throughout adulthood (Kelemen & Rosset, 2009; Lombrozo et al., 2007) and even among the most learned mechanistic reasoners (Kelemen et al., 2013).

Humans are also biased to believe that nature was created by an intentional supernatural agent (Järnefelt et al., 2015). The co-existence of this bias and the teleological bias suggests that the latter is a product of agency detection in the natural world, but research has yet to substantiate that link experimentally. This dissertation addresses whether people instinctively see design in nature because they assume it was intentionally created. Put differently, it addresses whether the teleological bias is rooted in agency detection.

### **Evidence of a Default Teleological Stance**

From the time they can speak their native language, children strongly prefer teleological explanations for nature's existence across all domains of natural and manufactured phenomena (e.g., Kelemen, 1999; Kelemen & DiYanni, 2005). Across a diverse array of cultures, children develop into adults who apply teleological reasoning

more selectively, more often restricting it to causal explanations of artifacts and biological phenomena (Casler & Kelemen, 2008; Lombrozo et al., 2007; Lombrozo & Carey, 2006; Rottman et al., 2017), likely because they learn to apply scientific reasoning to the mysteries of nature. However, education and development only partially suppress the impulse toward scientifically unwarranted teleological reasoning. Kelemen and colleagues (2013) found that undergraduates from prestigious universities with unlimited response time endorsed 45% of the unwarranted teleological explanations of nature they read (e.g., “Trees produce oxygen so that animals can breathe”) as true, while community members from outside the universities gave a 40% endorsement rate, consistent with previous findings of prevalence (Kelemen & Rosset, 2009). Post-graduate education predicted lower endorsement rates, with 21% among working scholars in the humanities and 15% among those in the physical sciences, but these figures clearly show incomplete suppression of teleological intuitions. Suppression is largely a function of applied scientific education and rejection of supernatural agency theories—the physical scientists in this study had the highest levels of scientific education and the lowest rates of teleology endorsement. Regression analyses showed that biological knowledge predicted lower teleology endorsement rates among all participant groups, while geoscience knowledge predicted lower teleology endorsement rates among undergraduates and community members. Belief in God predicted higher teleology endorsement rates among undergraduates and community members, while belief in Mother Nature predicted such among all participant groups.

The teleological bias that is so evident among children survives as a default mode of explanation among adults, who are more likely to prefer teleology when cognitive resources are strained. Kelemen and Rosset (2009) randomly assigned participants to rate the accuracy of teleological statements about nature, either with no time limit or a 3500ms time limit, finding that participants endorsed more teleological statements when time was limited. Kelemen, Rottman, and Seston (2013) replicated this effect in a sample of trained physical scientists despite ostensible group advantages in the content and accessibility of scientific theory. Researchers displayed scientifically unwarranted, but functionally plausible<sup>1</sup>, teleological explanations for each of several natural phenomena to physical scientists at elite American universities (e.g., Brown, Columbia, Harvard, MIT, Yale) and asked these participants to rate the explanations as true or false under either a 3500ms time constraint or under no constraint. Scientists in the time constraint condition endorsed significantly more unwarranted teleological explanations than their naturally paced counterparts. Kelemen and colleagues also found that physical scientists made no fewer mistakes than humanities scholars from the same institutions did, but both groups made fewer mistakes than a community sample did, suggesting a general effect of post-graduate education but no real advantage for specifically scientific education.

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<sup>1</sup> “The sun shines in order to warm the earth” is an example of unwarranted, but functionally plausible, teleology. “The sun shines in order to erode mountains” would be functionally implausible. To be clear, the researchers did include a false teleology condition that presented unfounded, illogical teleological statements. There was no effect of speed condition on endorsement of false teleological statements, but participants did endorse more plausible than false teleological statements, suggesting that they were processing the ideas before agreeing and thus the plausible teleological statements do initially ring true.

Notably, although highly educated individuals endorsed fewer unwarranted teleological explanations than their less educated counterparts did, the effect of the time constraint suggests that the natural inclination toward teleology remains even after extensive education. This finding has replicated in China (Rottman et al., 2017), whose culture is rooted in holistic philosophy and is among the most atheistic in the world (Morris & Peng, 1994; Norenzayan et al., 2002; see Rottman et al., 2017 for a discussion). Casler and Kelemen (2008) found a similar pattern among Romani adults, whose culture integrates elements of German and Hungarian tradition and includes believers in Muslim, Christian, and folk religions. Teleology was broadly preferred by children, adults tended to restrict it to artifacts, behaviors, and biological features, and education predicted stronger restriction when explaining non-living natural phenomena. The evidence suggests that the teleological bias and resulting cognitive default emerge reliably across cultures. Teleological explanations of nature enjoy cognitive primacy regardless of education and culture. Humans ubiquitously display a teleological bias that requires effortful cognition to overcome.

### **The Root of the Teleological Default**

By the promiscuous teleology (PT) account, children broadly apply design-based thinking to domains beyond its scientifically warranted purview because they assume a causal intentional agent must have created or purposed a given phenomenon. Similarly, adults' easily accessed teleological default would exist because highly sensitive agency detection would bias them to assume that orderly phenomena come from intentional agents. The "promiscuity" notion is well supported by findings that children apply

teleology across nature categories (e.g., Kelemen, 1999c; Kelemen & DiYanni, 2005) and that adults' teleological default was measured with items from unwarranted categories, such as non-living natural kinds (e.g., clouds; Kelemen et al., 2013; Kelemen & Rosset, 2009).

However, debate exists over PT's position that the teleological default is rooted in agency detection. The major challenge comes from findings that teleological explanations of nature do not require explicit belief in supernatural agency (Keil, 1995; Lombrozo, 2006; Lombrozo et al., 2007). Lombrozo and colleagues (2007) found that healthy elderly participants accepted teleological explanations of the same phenomena that they also attributed to natural selection, and that those with the memory-wasting Alzheimer's Disease accepted teleological explanations equally well regardless of their chosen design or natural selection stance. The suggestion here is that teleology need not be rooted in theoretical commitments to intentional agency behind nature. Rather, adults' intuitive teleological explanations could index a primitive cognitive assessment of the correspondence between the involved entities' forms and their proposed causal relationship<sup>2</sup>. Several studies suggest that this *structure-function fit* is a necessary component of an acceptable teleological explanation, and while agentic nature beliefs do predict more scientifically unwarranted teleological endorsements, they are not necessary for teleology to make sense (Kelemen et al., 2013; Kelemen & Rosset, 2009; Liquin & Lombrozo, 2018; Lombrozo et al., 2007).

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<sup>2</sup> Teleology is considered a "final cause" inasmuch as intentions lead to outcomes (Chase, 2011).

There is currently no experimental evidence that the teleological default observed in adults across the theistic belief spectrum is linked to agency detection. Kelemen et al (2013) described their finding that religious believers endorsed more teleological statements as evidence that the teleological stance is rooted in intuitions of causal agency, presumably because these participants believed in an intentional creator. In a follow-up study, they found that God beliefs and Mother Nature beliefs both predicted teleological endorsements, controlling for speeded responding condition. However, this was not a strong test of root intuitions because the results included both speeded and non-speeded response conditions, where cognitive reflection had time to occur, which would drive down the teleological endorsements for the scientifically minded non-believers. A better test would have been whether believers endorse relatively more teleological statements in the speeded conditions (Religion X Speed interaction) with smaller interactive effects more strongly suggesting a universal cognitive basis for the teleological bias. However, such a test could not explicate the qualitative roots of the teleological bias nor distinguish them from one another, still relying on the assumption that supernatural agency detection is the causal intuition.

In addition to a correlation between teleology and religion, the promiscuous teleology account gains support from the finding that people are biased to think that nature is purposefully created. Järnefelt and colleagues (2015) found that participants across the theistic belief spectrum were more likely to agree that nature was purposefully created when response time was limited. This finding suggests that it takes cognitive effort to suppress the intuition of intentional creation, as it does to suppress the intuition

of nature's purpose (Kelemen et al., 2013; Kelemen & Rosset, 2009; Rottman et al., 2017). The existence of these biases and the religion-teleology link point to the possibility that the teleological default is rooted in agency detection, but it might also be rooted in an anthropocentrism (Preston & Shin, 2020) or a largely asocial cognitive heuristic (Lombrozo et al., 2007; Ojalehto et al., 2013). Critically, no experimental evidence has drawn a causal link between intuitions of intentional creation intuitions and the intuitions of nature's purpose evident across the theistic belief spectrum. Probing this link provides a crucial test of the promiscuous teleology tenet that we tend to see purpose in nature *because* we assume it was created by a supernatural agent.

### **The Current Research**

The current research tests whether supernatural agency detection causes the teleological bias by probing whether thinking about nature's purposes causes thoughts about God. Finding that the nature teleology statements cause thoughts of God would suggest that participants in previous studies (e.g., Kelemen et al., 2013; Kelemen & Rosset, 2009; Rottman et al., 2017) agreed with them because of those thoughts.

### **Design and Analytic Plan**

The dependent variable was how quickly participants categorized the item "God" as real or imaginary, because faster judgment times imply more attitude accessibility (Fazio, 1986, 1989, 1990, 1995). If people reference the intentions of a supernatural creator for their nature teleology responses, then attitudes toward that creator should be temporarily more accessible. Attitude accessibility is determined by linkage with other constructs, frequency of activation, salience, or distinctiveness (Higgins, 1996; Krosnick,

1989). Participants asked to repeatedly express their attitudes respond faster to subsequent attitude probes (Fazio et al., 1982; Powell & Fazio, 1984). Because the nature teleology statements were expected to cause thoughts of supernatural agency (i.e., God), a measure of God thought accessibility was the dependent variable.

Increased God thought accessibility should have differential effects for theists and atheists. Jong et al (2012) primed participants with mortality salience, then measured their response latency to categorize religious words as either “real” or “imaginary” as part of a single target implicit association task. The primes made theists faster to respond with the expected “real,” but made atheists slower to respond with the expected “imaginary.” Both of these outcomes are consistent with participants having pro-religious thoughts in the wake of mortality salience because thoughts of God should make theists’ (God is real) beliefs more accessible but make atheists’ (God is imaginary) beliefs less accessible. Borrowing ideas from the aforementioned study and Cohen et al. (2008), the current study had participants rate God as real or imaginary in a choice response task. Both of the aforementioned studies measured religion accessibility with a network of religious items (e.g., heaven, angel), but the current study relies on the God concept alone because thoughts of a supernatural creative agent are the target idea.

In the current study, participants who identified as either atheist or theist were randomly assigned to a nature teleology condition or a human teleology condition, with their God thought accessibility measured before and after the manipulation. The data were analyzed primarily with a 2 (Theistic Belief) X 2 (Teleology) X 2 (Time) mixed ANOVA.



## **Hypotheses**

### ***Interactive Effect of Nature Teleology and Theistic Beliefs***

This is the main prediction for testing whether the teleological bias is rooted in the detection of supernatural agency. There should be a crossover interaction of nature teleology and theistic belief such that the nature teleology condition will decrease response latency for theists but increase response latency for atheists, relative to the human teleology condition.

### ***Effect of Nature Teleology***

Assuming that atheists' responses are slowed and theists' responses are speeded to an equal degree by thoughts of supernatural agency, and that there are equal numbers of each, there should be no main effect of nature teleology on response times overall.

### ***Effect of Theistic Beliefs***

Belief that nature is designed by an intentional causal agent is a natural intuition that requires cognitive effort to overcome—even among non-believing members of atheistic cultures (Järnefelt et al., 2015). Therefore, categorizing God as real should take longer than categorizing God as imaginary. There should be a main effect of theistic belief such that theists are faster to categorize “God” across both teleology conditions.

## Method

### Sample Planning

A power analysis for 2 x 2 x 2 mixed ANOVA with 0.8 power to find a small interaction effect size ( $f = .10$ ) and a conservatively estimated repeated measures correlation<sup>3</sup> of  $r = 0.2$  suggested a sample size of 444.

### Participants

Participants were first recruited from the ASU psychology subject pool to complete the study in exchange for 0.5 research credits. After collecting as many participants as possible by the end of the semester, preliminary analyses suggested the sample was not large enough and that theists outnumbered atheists by about 4:1. Additional participants were recruited through Prolific Academic to take the estimated 15-minute study in exchange for two U.S. dollars. Only participants who previously reported to Prolific that they were non-religious were recruited in order to balance the number of theists and atheists<sup>4</sup>. Recruits who reported either non-fluency in English or using a mobile device to take the study were routed to the survey exit. Subsequent analysis confirmed that none of the participants used a mobile operating system to take the survey. A pre-screening question for theism was undesirable because doing so might have influenced responses and recruitment, and so the sample does include some “agnostic” participants who were unsure whether they believed in God or not. However, given that I analyzed only those cases where participants gave the “correct” God response

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<sup>3</sup> The final measures had a correlation of  $r = .497$ .

<sup>4</sup> Subsequent testing confirmed no differences between the atheists from each sample.

(i.e., atheists responding that God is imaginary) and there is no “correct” answer for the unsure participant, the unsures were completely excluded from analyses. The final sample of theists and atheists reached the size suggested by the power analysis ( $N = 608$ ; 376 theists, 232 atheists;  $M_{\text{age}} = 24.73$ ,  $SD = 10.23$ , 29 missing; 199 males, 373 females, 7 other, 29 missing; 356 White, 73 Latinx, 43 Other/Multiple, 39 East Asian, 30 South Asian, 16 Middle Eastern, 4 Native, 29 missing).

## **Procedure and Materials**

### ***Pre-Experiment Survey***

Participants were first routed to Qualtrics. Echoing the recruiting dialogue, the consent letter informed them that the study must be completed on a laptop or desktop computer with a physical keyboard and that proficient use of English was required. After consenting to be studied, participants were asked to report the device they were using at the time; those reporting anything other than a desktop or laptop computer were routed to the end of the Qualtrics survey, completing the session.<sup>5</sup> The same process filtered out participants indicating that they were not fluent in English. The rejected undergraduate participants received credit for the study, while the rejected Prolific participants did not receive payment. Remaining participants then reported their age on a sliding scale of integers from 16-99.<sup>6</sup> Multiple choice items then gathered participants’ gender (Male, Female, Other) and ethnicity (i.e., race).

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<sup>5</sup> Subsequent analysis confirmed that none of the participants used a mobile operating system to take the survey.

<sup>6</sup> All participants were 18 or older.

A four-digit number was then randomly assigned to each participant by Qualtrics for the purpose of matching demographic data with experiment data. They entered the number into Qualtrics and were instructed to enter it in the participant number box on the upcoming second part of the study. Qualtrics then randomly assigned each participant to one of the four versions of the experiment (Teleology Condition X Left-Right Orientation)<sup>7</sup>, programmed in PsychoPy3 and hosted on the Pavlovia website. PsychoPy3 is the latest version of an open-access, chronologically precise experiment building program that is compatible with the online server, Pavlovia (Peirce et al., 2019). The programmed PsychoPy experiments were synced with my account at Pavlovia, providing a separate web address for each of the four experiment versions to which participants were randomly assigned. Stimuli were presented in white on a gray background unless otherwise noted.

### ***Experiment Practice Session***

Once routed to the Pavlovia hosting website, participants entered the randomly assigned 4-digit number into a typical participant number box commonly displayed on lab experiment software. All participants then began a practice session to prepare them for the main tasks. The following instructions were given to the left orientation conditions; terms in brackets represent the alternative instructions provided in the right orientation conditions. *In the following activity, you will see a thing, person, or place presented at the center of the screen. Your job is to decide if this thing, person, or place*

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<sup>7</sup> The corresponding values of D and K were randomly assigned in one of two versions to account for “side” effects.

*is real or imaginary as quickly as possible. For example, a fictional character would be imaginary, while a desk or a rock would be real. Place a left-hand finger over the "D" key and a right-hand finger over the "K" key. If the stimulus represents something real [imaginary], press D as quickly as possible. If the stimulus represents something imaginary [real], press K as quickly as possible. The most important goal is to be accurate, but make your correct response as quickly as possible. Press space bar to continue to a brief practice session. Focus on the cross in the middle of the screen and then respond to each of the words that appear. There will be a similar, but briefer, fixation cross between each word.*

After pressing the space bar, the reminders  $D = Real$  [ $D = Imaginary$ ] and  $K = Imaginary$  [ $K = Real$ ] appeared prominently on the screen for four seconds, followed by a two-second display of a centered fixation cross, followed by the first randomly ordered, centered item from the practice list (Table 1). Upon selecting their response, the item was replaced by a centered fixation cross, which was displayed for 250ms and then replaced by the next randomly ordered, centered word from the control item list. This cross-item-response cycle continued until each of the items had been displayed twice in random order (Figure 1). No feedback was given, but the vast majority of participants understood the task as evidenced by high proportions of correct responses in the upcoming experiment.

### ***Pre-Test***

After completing the practice session, participants were shown the following instructions. *Now that you have had the chance to practice, it is time for the main*

activity. The instructions are the same. As each word is presented, categorize it as either real [imaginary] or imaginary [real] as accurately and quickly as possible using the "D" and "K" keys. In the space below, the following reminders were given:  $D = Real$  [ $D = Imaginary$ ] and  $K = Imaginary$  [ $K = Real$ ].

**Table 1**

*Control Items*

Correct Classification	
Real	Imaginary
Airplane	Bugs Bunny
Car	Captain Kirk
Chair	Darth Vader
House	Easter Bunny
Moon	Homer Simpson
Rain	Leprechaun
Sun	Superman
Water	Tooth Fairy

*Note.* Control item list used in the practice, pre-test, and post-test phases, adapted from (Cohen et al., 2008). The target item “God” was added to the list for both test phases.

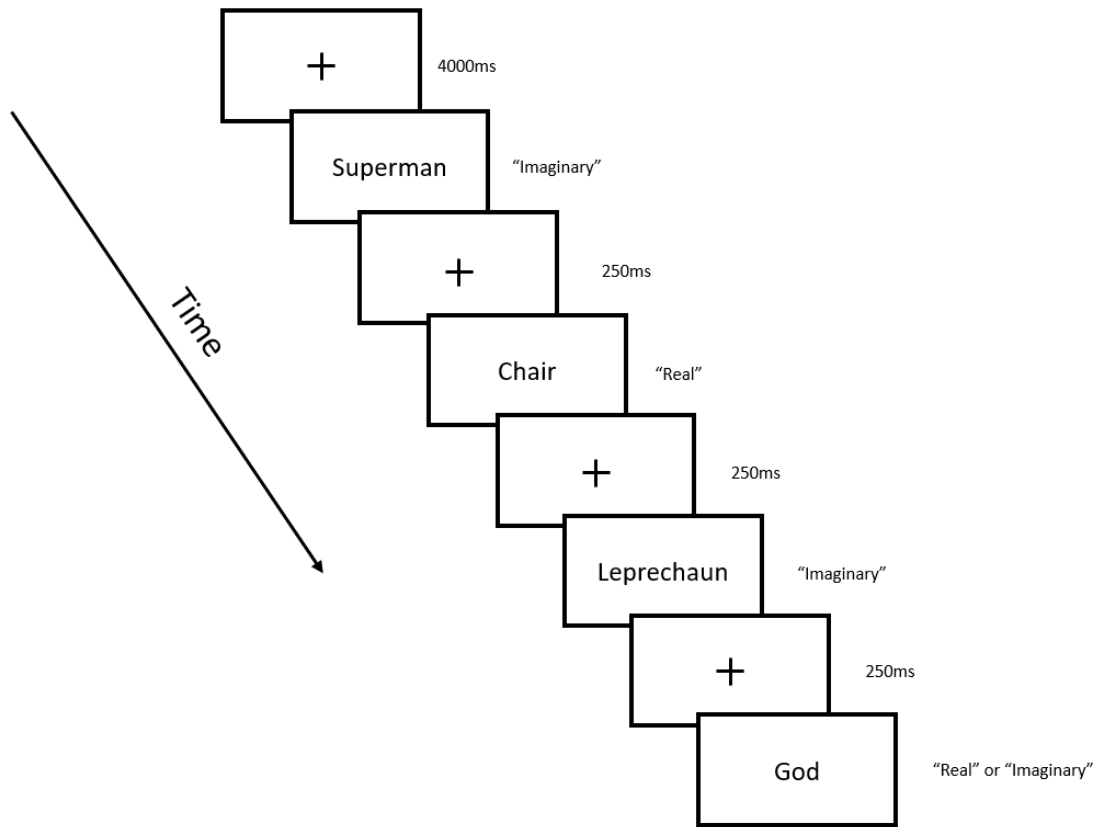
The response and timing process was identical to the practice session, with the same four-second key reminder, two-second fixation cross, and the same items (and the target word “God”) presented four times each in random order, for a total of 68 responses.

***Teleology Manipulation***

Each participant then entered the randomly assigned teleology manipulation with the following instructions: *You will now see a series of one-sentence statements. Rate how much you agree or disagree with each of these statements on the scale provided. Rate them at your natural pace. There is no need to answer quickly. Select your answer*

**Figure 1**

*Schematic Diagram of Timed Response Choice Task*



*Note.* Initial fixation cross appeared immediately following advancement from the instructions page. Participants classified stimuli as “Real” or “Imaginary” as accurately and quickly as possible by pressing “D” or “K.” Each word (except “God”) appeared twice in the practice session in random order. Each word (including “God”) appeared four times in the test sessions in random order.

*by typing a number from 1-6. 1: Strongly Disagree, 2: Disagree, 3: Slightly Disagree, 4: Slightly Agree, 5: Agree, 6: Strongly Agree...Press space bar to proceed. After pressing space bar, the first randomly ordered teleology statement appeared in the center of the screen, with the response reminders (e.g., 1: Strongly Disagree) consistently displayed in*

black on the top of the screen. Participants rated their agreement with the 27 randomly ordered teleology statements from their assigned experimental condition (Human vs. Nature) at their own pace using the numeric keys 1 through 6.

The nature teleology items came from previous work assessing people's belief in a the purposes of natural phenomena (Kelemen et al., 2013; see Supplemental Materials). There were 27 items including "Trees produce oxygen so that animals can breathe" and "Ferns grow at ground level in order to conserve humidity." All of the items presented purposes of nature that could not be intended by any earthly organism. Five items involved the actions of animated beings (e.g., "Birds transfer seeds in order to help plants germinate") but the presented functions seem very likely beyond the beings' awareness, meaning that they could plausibly be intended by God but not by the beings themselves, and thus they were suitable for inclusion.

Human teleology items came from the same study as the nature teleology items (Kelemen et al., 2013). These items reflected functions with human intentions in order to preserve the teleological thought factor but eliminate the effect of interest (i.e., supernatural agent intentions). Equalizing the mean levels of agreement between the human and nature teleology conditions was attempted in order to remove the confounding effects of reading true vs. false statements. Responses to the nature teleology items are bound to vary across belief systems such that atheists agree with them less than theists do. If all of the human teleology items were true statements, atheists in the nature condition would see a list of statements with which they do not agree, as opposed to the widespread agreement they would enjoy in the human condition. Kelemen et al.'s (2013)



study provided ten true and ten false mundane teleology items. The remaining seven were adapted from Kelemen et al.'s "true causal" items to reflect teleology. For example, the item "A lightbulb shines because electricity passes through its filaments" was adapted to read "Electricity passes through a light bulb's filaments in order to make it shine." These adapted items were aimed at balancing "true" and "false" teleology while avoiding any plausible direct connections to divinity.

### ***Post-Test***

After responding to the 27 teleological statements, participants saw the following instructions: *The next activity is to once again categorize people, places, and things as accurately and as quickly as you can. The instructions are exactly the same as they were before. As each word is presented, categorize it as either real [imaginary] or imaginary [real] as accurately and quickly as possible using the "D" and "K" keys.* In the space below, the following reminders were given: *D = Real [D = Imaginary] and K = Imaginary [K = Real].* The task was otherwise identical to the pre-test.

### ***Theistic Belief***

Participants indicated whether they believed in God by entering a number in response to the following instructions: *Which of these best captures your current beliefs about God, Higher Power, Universal Spirit, etc.? Do you believe it exists, not believe it exists, or are you completely unsure? Enter a number that describes your beliefs: 1 = I have at least some belief that God exists; 2 = I have absolutely no belief that God exists; 3 = I am unsure how to answer.*

### ***Exit***

Participants then indicated with a keystroke whether their data should be used. Following this, they were debriefed, thanked, and redirected to either Prolific or SONA to receive compensation.

## **Results**

### **Data Cleaning**

Responses were first analyzed for qualitative correctness with different expectations for different participants and items. Responses to control items (which were either patently real or patently imaginary) were judged by a single correctness standard. Responses that God is real counted as correct for theists, but incorrect for atheists. Likewise, responses that God is imaginary counted as incorrect for theists but correct for atheists. There was no correct God response for those who were unsure about their beliefs, so these participants were excluded from all analyses except where noted in the results. After removing all of the incorrect responses, all responses shorter than 200 milliseconds or longer than 3000 milliseconds were removed. Within-subject means for response latencies on correct trials were then calculated and responses greater than three standard deviations from the within-subject means were removed. Each remaining response latency was then transformed into its natural logarithm, and then averaged to form four mean response latency values: Control and target items at pre- and post-manipulation. All of the response latency analyses use the means of log-transformed correct responses as dependent variables, while their attached figures display the means of untransformed correct responses.

## **Preliminary Checks**

### ***Testing the Effects of Recruitment Pool***

A preliminary test of the effect of recruitment pool looked for differences between the undergraduate and the Prolific sample. A difference in theism was expected because the Prolific pool was drawn from those who had indicated being non-religious in a worker survey, so this test controlled for belief in God.<sup>8</sup> A mixed ANCOVA with pre- and post-manipulation God measures as dependent variables, controlling for God belief, showed no effect of sample on within-subjects change,  $F(1, 537) = .781, p > .37$ . A supplementary repeated measures ANCOVA with sample, theism, and teleology condition as between-subjects factors confirmed no effect of sampling pool on the results ( $ps = .29 - .75$  for effects that included sampling pool). Therefore, sampling pool is not included in any analyses going forward.

### ***Testing the Effect of Keyboard Orientation***

Participants were randomly assigned to conditions where the meaning of “D” and “K” were either “real” and “imaginary,” respectively, or vice versa. A mixed ANOVA with pre- and post-manipulation God response latencies as the dependent variables and left vs right orientation as the between-subjects factor showed no effect of orientation on within-subjects change,  $F(1, 538) = 2.087, p > .14, \eta_p^2 = .004$ . A supplementary mixed ANOVA with orientation, God belief, teleology condition, and their interactions as between-subjects factors showed no effect of orientation ( $ps = .24-.75, \eta_p^2s < .004$  for

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<sup>8</sup> The undergraduate sample contained 281 theists, 72 atheists, and 79 unsures. The Prolific sample contained 26 theists, 130 atheists, and 60 unsures.

effects that included orientation). Therefore, keyboard orientation is not included in any analyses going forward.

## **Hypothesis Tests**

### ***Interaction of Teleology and Theism***

Supporting the main hypothesis, there was a significant interactive effect of theism and teleology condition on within-subjects change in response latency to categorize God,  $F(1, 536) = 4.618, p = .032, \eta_p^2 = .009$ , such that atheists were relatively slower to categorize God in the nature teleology condition (Figure 2). There was no main effect of teleology condition on within-subjects response latency change,  $F(1, 536) = .135, p > .71, \eta_p^2 < .001$ . There was a main effect of theism on within-subjects change in this model,  $F(1, 536) = 6.251, p = .013, \eta_p^2 = .009$ . Theism had the expected effect of lengthening response latencies overall, collapsed across pre- and post-manipulation measurements,  $F(1, 536) = 30.343, p < .001, \eta_p^2 = .054$ . There was no such effect of teleology condition,  $p > .60$ . Common to all of the mixed ANOVAs presented in this report, there was a significant main effect of time (pre- vs. post-manipulation; all  $ps < .001, \eta_p^2s = .209-.225$ ; Appendix C). See *Table 2* for means, standard errors, and 95% confidence intervals in all experimental cells. These results support the prediction that consideration of the nature teleology items would cause theists and atheists to think about a supernatural agent.

### ***Effect of Nature Teleology***

The second prediction was that there would be no main effect of teleology type because if thinking about natures' purposes involved taking God's perspective, atheists

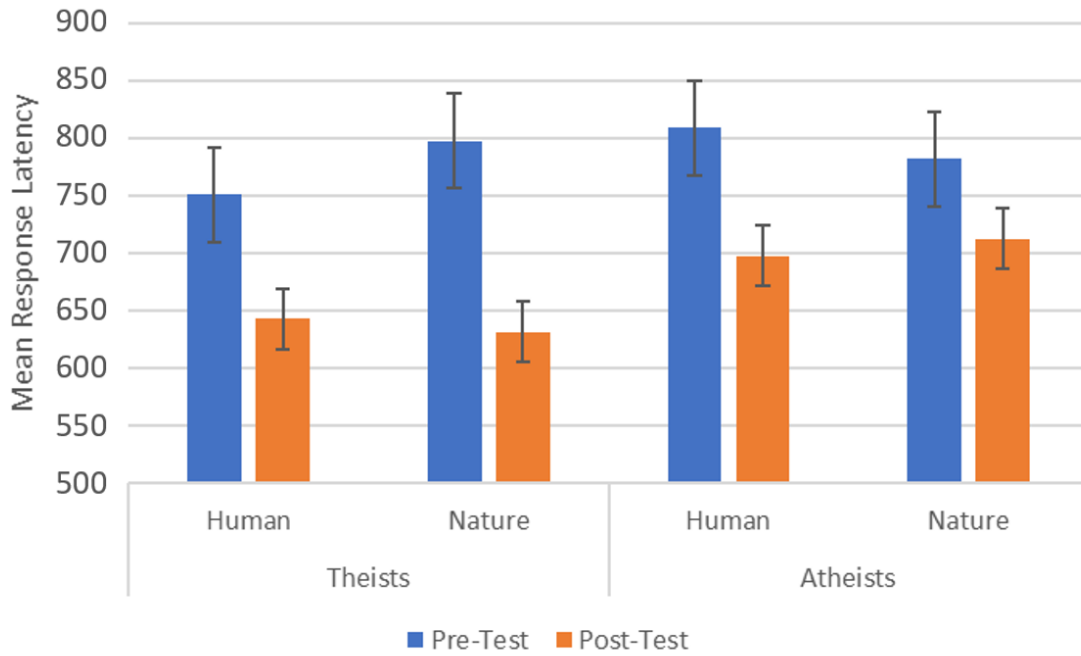
would be slower to answer “imaginary” and theists would be faster to answer “real.” As a supplement to the full model above, a mixed ANOVA with just teleology condition as the between-subjects factor showed no effect on the within subjects change in response latency,  $F(1, 538) = .52, p > .47, \eta_p^2 = .001$  (Figure 3). In addition to the lack of a within-subjects effect, there was also no between-subjects effect when collapsing across pre- and post-manipulation response latencies,  $F(1, 538) = .47, p > .49, \eta_p^2 = .001$ . These results support the prediction that the supernatural agent thoughts engendered by consideration of the nature teleology items would affect theists and atheists differently.

### ***Effect of Theism***

Categorizing God as real (the theist response) was predicted to take longer than categorizing God as imaginary (the atheist response). There should be a main effect of belief such that theists are faster to categorize God in general. This hypothesis was supported in the full model above and in a supplementary mixed ANOVA where theism was the singular between-subjects factor. In the latter model, there was an effect of theism on within-subjects change,  $F(1, 538) = 6.63, p = .01, \eta_p^2 = .012$ , such that atheist participants showed less relative response speeding at post-test (Figure 4). There was also a main effect of theism on response latencies collapsed over time,  $F(1, 538) = 30.335, p < .001, \eta_p^2 = .053$ . These results support the idea that categorizing God as real aligns with human intuition more so than categorizing God as imaginary.

**Figure 2**

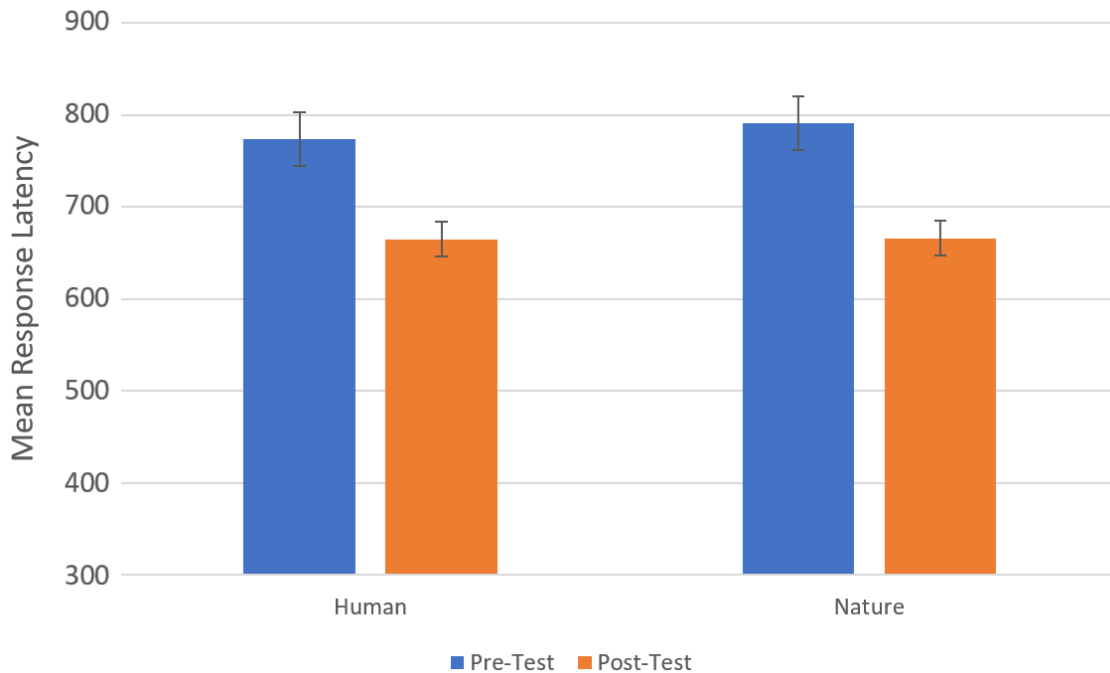
*Mean Response Latencies to Categorize God as Real or Imaginary as a Function of Teleology Type and Theistic Beliefs*



*Note.* Measured in milliseconds. Error bars represent 95% confidence intervals.

**Figure 3**

*Mean Response Latencies to Categorize God as Real or Imaginary as a Function of Teleology Type*



*Note.* Measured in milliseconds. Results are collapsed across theism and atheism. Error bars represent 95% confidence intervals.

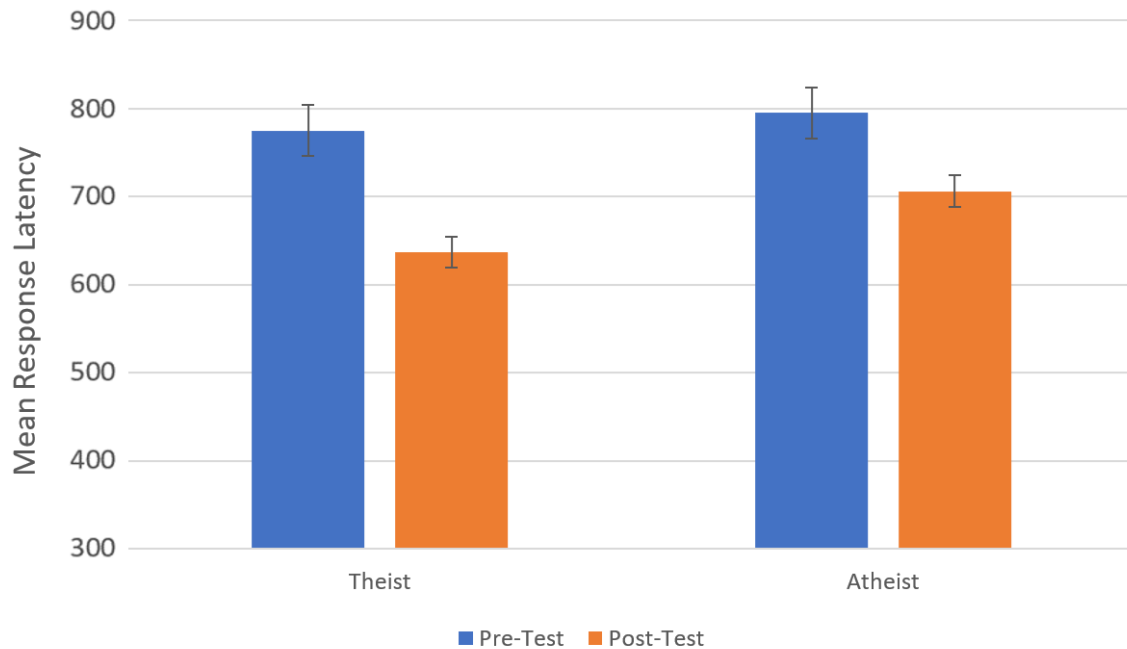
### **Other Tests**

#### ***Testing Whether the Manipulation Affected Response Accuracy***

Another way to test the main hypothesis would involve looking for differences in substantive answering. Specifically, atheists who had been primed with God would show a decrease in response accuracy, whereas theists would show no difference. The proportion of correct God responses at pre-test and post-test were calculated for each participant in line with their stated theistic beliefs.

**Figure 4**

*Mean Response Latencies to Categorize God as Real or Imaginary as a Function of Theistic Belief*



*Note.* Measured in milliseconds. Results are collapsed across human and nature teleology. Error bars represent 95% confidence intervals. Theist responses were that God is real. Atheist responses were that God is imaginary.

A mixed ANOVA with the proportion of correct responses as a repeated measure, along with teleology condition, theism, and their interactions as between-subject factors, showed no effect of teleology condition,  $F(1, 604) = .096, p > .75, \eta_p^2 < .001$ , a main effect of theism,  $F(1, 604) = 8.467, p = .004, \eta_p^2 = .014$ , and no interaction of teleology and theism,  $F(1, 604) = .034, p > .85, \eta_p^2 < .001$ .<sup>9</sup> Contrary to expectations, the effect of

<sup>9</sup> The N was larger because participants with zero “correct” responses would not have had a mean RT value.



theism was that atheists had higher response accuracy than theists (Figure 5). Controlling for control item accuracy did not change the pattern of results. See *Table 3* for means, standard errors, and confidence intervals in all groups. See *Appendix C* for the full ANOVA table. Although the nature teleology items increased atheists' response latency to categorize God as imaginary, the atheists' response accuracy increased at post-test in both teleology conditions, whereas there was no such change for theists, suggesting that the pre-test affected atheists' (but not the theists') post-test response accuracy.

### ***Confirmatory Test of the Theism-Teleology Connection***

Theists should endorse relatively more teleological statements about nature than atheists do because the former believe that nature was created intentionally, and much work has shown such a relationship (e.g., Kelemen et al., 2013). The current study tested this idea by comparing the mean response to the nature teleology statements among theists, atheists, and the unsure.<sup>10</sup> Theists should endorse the most nature teleology, followed by the unsure, with atheists endorsing the least nature teleology. A between-subjects ANOVA followed by Bonferroni-corrected pairwise comparisons comprised the analysis. There was evidence for an overall difference between groups,  $F(2, 408) = 9.296$ ,  $p < .001$ ,  $\eta_p^2 = .044$ . Pairwise comparisons revealed that theists ( $M = 4.37$ ,  $SD = .85$ ) endorsed more nature teleology than atheists ( $M = 3.88$ ,  $SD = 1.23$ ;  $p < .001$ ), who endorsed marginally less teleology than the unshures ( $M = 4.18$ ,  $SD = .89$ ;  $p = .067$ ). There was no significant difference between theists and the unshures ( $p > .36$ ). This finding

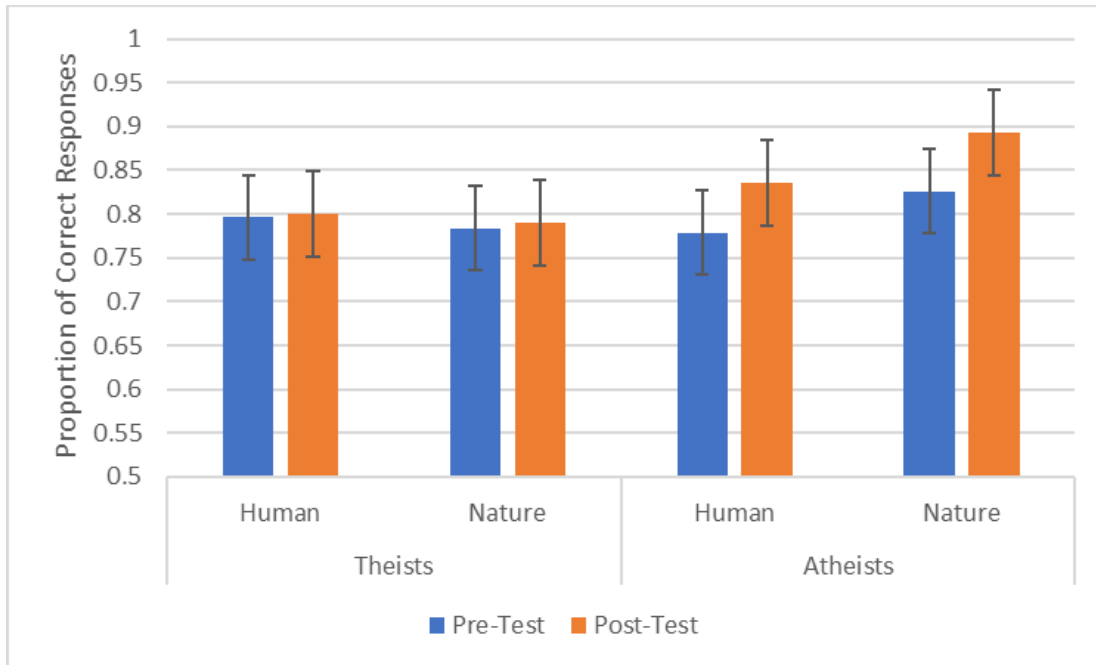
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<sup>10</sup> Responses to human teleology statements would be uninformative because their veracity does not depend on theistic belief.

supports previous work showing that religion is associated with teleological thoughts about nature (e.g., Kelemen et al., 2013).

**Figure 5**

*Mean God Response Accuracy Across Theism and Teleology Conditions*



*Note.* Error bars represent 95% confidence intervals.

## Discussion

### Review of Support for Hypotheses

The main hypotheses were supported by the data, with some minor caveats (see below). There was a significant interactive effect of theism and nature teleology on within-subjects changes in response latency such that nature teleology had a relative slowing effect on atheists, compared to theists. In the nature teleology condition, atheists

were faster than theists at categorizing God in the pre-test, but then were slower than theists in the post-test. There was an effect of theism on both within-subjects response latency changes and on the average participant response latency, such that atheists were relatively slowed at post-test and were slower overall to categorize God as imaginary than theists were to categorize God as real. Lastly, there was no overall effect of nature teleology due to the interaction with theism, as predicted.

Overall, the results indicate that thinking about the purposes of natural phenomena caused both theists and atheists to consider a supernatural agent. This consideration had a speeding effect on theists' responses that God is real, but a relative slowing effect on atheists' responses that God is imaginary. Thus, a link is drawn between the teleological bias and detection of supernatural agency.

**Table 2**

*Means, Standard Errors, and Confidence Intervals for Response Latencies*

Teleology Condition	God Belief	Time	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Human	Theist	Pre	.751	.019	.713	.789
		Post	.643	.012	.619	.667
	Atheist	Pre	.809	.023	.763	.855
		Post	.698	.015	.669	.727
Nature	Theist	Pre	.798	.019	.761	.835
		Post	.632	.012	.609	.655
	Atheist	Pre	.782	.022	.738	.825
		Post	.713	.014	.686	.741

**Table 3***Means, Standard Errors, and Confidence Intervals for God Response Accuracy*

Teleology Condition	God Belief	Time	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Human	Theist	Pre	.796	.022	.754	.839
		Post	.800	.022	.756	.844
	Atheist	Pre	.779	.028	.725	.833
		Post	.836	.029	.780	.893
Nature	Theist	Pre	.784	.021	.742	.825
		Post	.790	.022	.747	.834
	Atheist	Pre	.826	.027	.773	.878
		Post	.893	.028	.838	.948

**Theoretical Implications**

The results of this study support the promiscuous teleology account that humans are biased to see purpose and design in nature because they perceive a supernatural agent that is responsible for its existence. The results suggest that thinking about the purpose of natural phenomena primed participants across the belief spectrum with the notion of God, implying that they considered God when assessing their agreement with the set of teleological statements. As predicted, relative to their counterparts in the human teleology condition, exposure to the nature teleology statements made theists faster to subsequently categorize God as real but made atheists slower to categorize God as imaginary. This is an expected result of having primed both groups with the notion of God in light of previous findings (Jong et al., 2012).

Results also supported previous findings that the accessibility of religious beliefs can be assessed by reaction time methods (Cohen et al., 2008) given that theists were faster to categorize God as real as a result of stimuli that ostensibly primed them with God-related thoughts. Conversely, the same stimuli that is thought to have reduced atheists' access to their belief that God is imaginary slowed their responses to that effect.

Some of the findings did not follow theoretical expectations. First, at pre-test, atheists categorized God more quickly than theists did, contrary to the prediction that theists would be faster due to having belief system that is more aligned with the default intuition of a supernatural creative agent (Järnefelt et al., 2015). This might be explained by relative cognitive advantages in the atheist sample, given the established negative correlation between religious beliefs and general intelligence (Zuckerman et al., 2013). Another unexpected finding was that atheists were more likely to “correctly” categorize God as imaginary at post-test. An explanation for this result is currently elusive.

### **Limitations**

The experimental method had several limitations of differing importance to the findings and to theory. Perhaps most notable was the small time gap between the pre-test and the post-test. The priming and familiarity effects of the pre-test were likely still active at the time of the post-test, evidenced by the large reduction in response latencies across all conditions. Inasmuch as the pre-test target items primed thoughts of God, they may have masked the same effect coming from the nature teleology manipulation. The effect of the manipulation did exist above and beyond that of the pre-test, but its actual effect may be larger than the observed one. This is not to say that the current design is

flawed because a larger time gap would likely have introduced more within-subject variance from innumerable other sources. The short time gap between pre-test and post-test introduced a minimum of within-subjects variance by theoretically controlling environmental and physiological changes between tests.

Basing the mean response latencies on four or fewer trials probably introduced unwanted within-subjects variance relative to designs with more trials. The time it takes to respond with a reasoned choice is highly variable even within persons—a larger number of trials would have increased power to detect an effect by reducing error in the mean estimates. As with the short time gap, the decision to have just four God trials served a positive function in that it reduced the unwanted priming that would come with a higher number. The experiment's manipulation was intended to prime thoughts of God, and already faced competition from the pre-test, so the priming that would result from a large number of trials may have masked the teleology effect beyond detectability.

Online administration of any study can increase variance relative to a controlled lab environment, but the precise response time data for this experiment was perhaps especially susceptible to electronic and environmental influence. The PsychoPy-Pavlovia combination used in the current study is among the most chronologically precise in the industry (Bridges et al., n.d.), but no platform is perfect and display frame rates vary across participants' devices. The precise nature of the current data maximized whatever effects of technological variance were there. Fortunately, the repeated measures design should have reduced such unwanted variance.

Although this study included atheists who identified themselves by agreeing that they have absolutely no belief in God (rather than merely selecting “atheist” from a list), it is possible that the effect was an artifact of sampling within the United States, where religious beliefs and expressions have long permeated the cultural milieu and even the staunchest of atheists are regularly exposed to religious content. However, previous research indicates that the current findings would be expected to replicate in strongly atheist cultures. Participants in Finland—a country that is largely free of religious belief and expression—demonstrated a bias toward believing the world was intentionally created (Järnefelt et al., 2015), while the teleological bias has replicated in the similarly irreligious People’s Republic of China (Rottman et al., 2017; Schachner et al., 2017). Given the relatively strong form of atheism in the current participants and the replication of related findings in atheist countries, the sampling pool may not be a limitation.

The fact that consideration time for the teleological statements was unrestricted limits the implications of this study for the teleological bias. Numerous demonstrations of the adult teleological bias have used speeded response tasks to show that agreement with teleology is relatively automatic. In terms of dual-process theory, teleological responses are intuitive, whereas as non-teleological responses require more reflection. If the automatic intuition is the phenomenon of interest, then limiting the current participants teleological statement response time to that chronological realm might better assess whether the automatic intuition is based on agency detection. It is possible that the current study measured the increase in supernatural agent thoughts that happened in the reflective period, rather than in the automatic intuition period, meaning that the results do

not explain what causes the teleological default but rather what causes reflective teleology.

### **Future Directions**

Future research might well address the limitations of the current study. Especially important is a study in which response time to the teleological statements is limited (to around three seconds based on previous research (Kelemen et al., 2013; Kelemen & Rosset, 2009)). Adding a speeded vs. unspeeded factor to the current design would permit a more stringent test of the source of the automatic teleological default as well as a test of whether atheists are affected by God thoughts during the reflective period. The latter is interesting because current theories do not elucidate the atheistic suppression process beyond that of initial intuition. Suppressing intuitive theism might require vigilance beyond defeating a single event, whether consciously or not. Given the online nature of the current study, a lab replication with or without suggested changes would be valuable, likely showing larger predicted effects. A replication in a staunchly atheist culture would also lend worthwhile support to the current findings.

Future research should investigate how other strains of teleological biases also stem from the assumption of a supernatural agent. One notable other strain would be specifically looking at natural events that are more or less salient to the participant because these are often explained in terms of their function as well (Banerjee & Bloom, 2014; Stephens et al., 2013). Whereas the nature teleology items in the current study mentioned a range of natural phenomena, natural events might seem even more connected to a supernatural agent because they involve action without a visible actor.



Moreover, natural events with more personal relevance should evoke relatively more agency detection because the mind would be more motivated to find an answer, which might not be easily forthcoming without meteorological knowledge. The teleological bias seems to be stronger for human-relevant natural phenomena, and humans are more likely to agree that nature was designed for them than for other living things. For example, participants are more likely to agree that the ozone layer exists to protect humans than to protect pigs, cows, or other animals (Preston & Shin, 2020).

Neuroscientific research could provide relatively concrete support for the suggestive findings in the current study because numerous varieties of religious thought have been linked to specific areas of the brain. Studies of fMRI data have shown that perceiving supernatural agents or reading statements about God's lack of involvement engage brain networks associated with intent and emotion aspects of Theory of Mind (Kapogiannis et al., 2009, 2014), suggesting that thinking about nature's purposes might also engage these or related networks. More concrete forms of evidence such as fMRI data would reduce the current result's reliance on inductive reasoning. A finding that considering the purposes of nature activates areas associated with thinking about God's intentions would add valuable support to the current result.

The current findings seem likely robust to differences in cultural levels of religion, but the effects of cultural variation in mentalizing are less predictable. Anthropological evidence shows a widespread belief among Pacific cultures in opacity of mind—the belief that intentions and thoughts are unknowable (Besnier, 1993; Duranti, 1992; Keane, 2002; McKellin, 1990; Ortner, 1989; Robbins, 2008; Robbins & Rumsey,

2008; Schieffelin, 2008; Stasch, 2008)—which suggests that thinking about supernatural agents’ intentions might not be a cultural universal. No psychological evidence of a teleological bias among opaque mind cultures has been reported, nor has a bias to perceive supernatural agency. Replicating the current or similar findings among such cultures could provide an even more stringent test than doing so among atheistic cultures because children are taught to avoid thinking about others’ minds from an early age. Rejecting all reasoning about intentions creates a challenging environment in which to replicate an intention-based teleological bias.

Research still needs to adjudicate between the intentional aspects and the non-intentional aspects of the teleological bias. The current experiment examined the link between the teleological view of nature and thoughts of a presumably intentional supernatural agent, but it has not ruled out the existence of a non-intentional basis for teleological reasoning that potentially interacts with the intentional basis. The current results suggest that consideration of supernatural agency influences people’s agreement with teleological statements about nature, but the possibility remains that the structure-function fit heuristic is yet more primary. For example, a statement with poor structure-function fit (e.g., “Trees exist to make light”) is not a plausible candidate for design and therefore might bypass thoughts about intention, whereas a plausible statement (e.g., “Trees exist to make food”) might merit mentalizing. Other researchers have demonstrated the concept of teleological generics, or the prototypical functions of an artifact that can license widely acceptable teleological statements (Korman & Khemlani, 2020). For example, “cars are for driving” is a widely acceptable teleological statement,

but “cars are for parking” is not because parking is incidental to a car’s main intended use, which is driving. People might need to have a plausible function “in hand” before intentionality becomes a consideration, which would mean that the teleological bias is actually not primarily rooted in agency detection, but rather a proclivity to find function, possibly for its own sake. Alternatively, the intuited intentions of a perceived agent might influence which teleological explanations are deemed functionally acceptable. Future research would do well to disentangle the evidence for multiple bases of the teleological bias.

### **Conclusion**

The proffered evidence supports the notion that we see purpose in nature because of the intuition that it was created by a supernatural agent, slightly illuminating the reasons we are continually vexed by existential questions. Intuition tells us that the physical world was intentionally created, which in turn makes us see purpose throughout the earthly realm and beyond. Although teleological and scientific reasoning are often at odds, our proclivity to find function is undoubtedly useful in the pursuit of knowledge.

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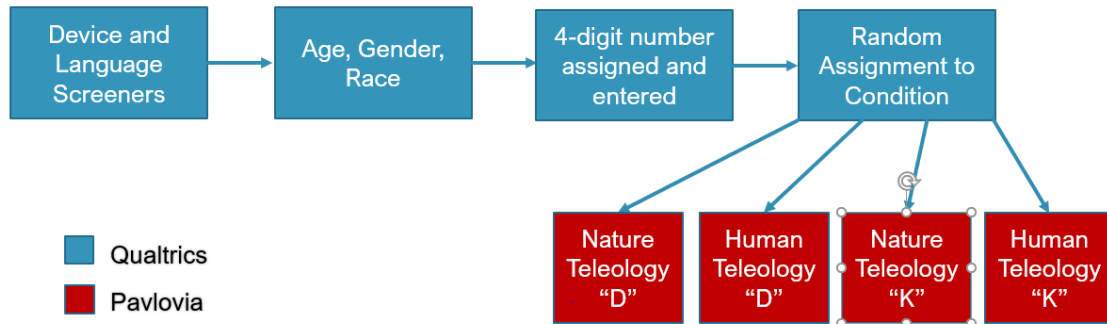
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APPENDIX A  
PROCEDURE AND MATERIALS

Figure A1

*High-Level Diagram of Participant Procedure and Routing*



Pre-Experiment Survey (Qualtrics)

*Consent Form*

**RESEARCHERS:** Matthew J. Scott, Graduate Student; Adam B. Cohen, Professor; Psychology, Arizona State University.

**DESCRIPTION:** This is a study of people's beliefs about nature. You will answer some survey items and then be asked to categorize words as quickly as possible using one of two keys. This study must be performed on a computer with an analog keyboard. The study should take around 15 minutes.

**RESTRICTIONS:** You must be 18 years or older to participate in this study. You must read English proficiently to participate. This study must be taken on a laptop or desktop computer with a physical keyboard. Other devices will be restricted from participation.

**RISKS:** There are no known risks from taking part in any of these studies.

**COMPENSATION:** We appreciate your participation and you will receive 0.5 research credits [author note: "\$2.00 US" for Prolific recruits] for completing this study.

**CONFIDENTIALITY:** Your responses in the survey will remain anonymous. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you in any way.

**WITHDRAWAL PRIVILEGE:** Participation in any of the studies is completely voluntary. It is okay for you to say no. It is okay to stop the study or to skip any question you do not want to answer; however, you must complete the study in order to receive credit.

**CONSENT:** Participation in this study will be considered evidence of your voluntary consent. Any questions you have concerning this research or your participation in the study can be answered by Matthew Scott (matthew.j.scott@asu.edu) or Dr. Adam Cohen (adam.cohen@asu.edu). If you have questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

Thanks for helping with this research. If you consent to participating in this survey, advance to the next page to continue.

#### *Device Check*

What kind of device are you using to take this survey? This question must be answered to participate further.

- Desktop Computer
- Laptop Computer
- Tablet
- Smartphone
- E-reader
- Other

#### *English Check*

How well do you understand English?

- I do not speak English
- I understand most English words
- I am fluent in English

#### *Age*

How old are you?



### *Gender*

What is your gender?

- Male
- Female
- Other \_\_\_\_\_

### *Ethnicity*

How would you BEST describe your ethnicity?

- Caucasian or White
- African-American or Black
- Hispanic, Latino, or Chicano
- East Asian
- South Asian
- Middle Eastern
- Native/Indigenous
- Other/Multiple \_\_\_\_\_

### *Participant Number Selection*

You should see a 4-digit number below. Write this number down. You must enter this number to participate in the next part of the study and ultimately receive research credit. When you get to the next part of the study, enter this four digit number as your participant number. These numbers must match in order to confirm your participation.

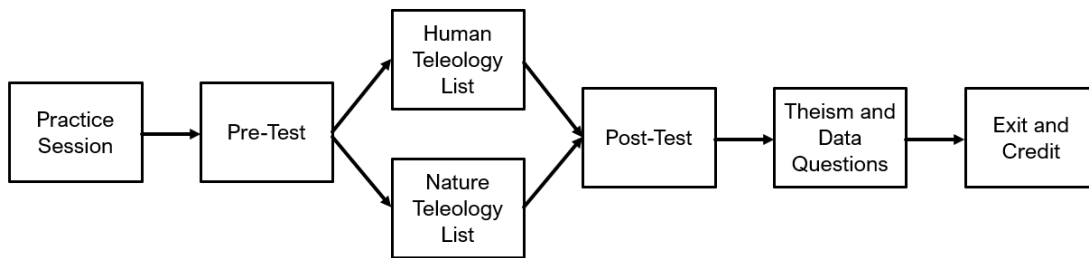
Your number is  $\{\text{rand://int/0001:9999}\}$

Please enter the number in the box below. You will enter it again in the next part of the study.

---

Figure A2

*Diagram of Experiment Procedure*



Experiment (PsychoPy & Pavlovia)

*Practice Instructions Left*

In the following activity, you will see a thing, person, or place presented at the center of the screen. Your job is to decide if this thing, person, or place is real or imaginary as quickly as possible. For example, a fictional character would be imaginary, while a desk or a rock would be real.

Place a left-hand finger over the "D" key and a right-hand finger over the "K" key. If the stimulus represents something real, press D as quickly as possible. If the stimulus represents something imaginary, press K as quickly as possible. The most important goal is to be accurate, but make your correct response as quickly as possible.

Press space bar to continue to a brief practice session. Focus on the cross in the middle of the screen and then respond to each of the words that appear. There will be a similar, but briefer, fixation cross between each word.

*Practice Instructions Right*

In the following activity, you will see a thing, person, or place presented at the center of the screen. Your job is to decide if this thing, person, or place is real or imaginary as

quickly as possible. For example, a fictional character would be imaginary, while a desk or a rock would be real.

Place a left-hand finger over the "D" key and a right-hand finger over the "K" key. If the stimulus represents something imaginary, press D as quickly as possible. If the stimulus represents something real, press K as quickly as possible. The most important goal is to be accurate, but make your correct response as quickly as possible.

Press space bar to continue to a brief practice session. Focus on the cross in the middle of the screen and then respond to each of the words that appear. There will be a similar, but briefer, fixation cross between each word.

### *Test Instructions Left*

Now that you have had the chance to practice, it is time for the main activity. The instructions are the same. As each word is presented, categorize it as either real or imaginary as accurately and quickly as possible using the "D" and "K" keys.

D = Real

K = Imaginary

Press the space bar when you are ready for the activity.

### *Test Instructions Right*

Now that you have had the chance to practice, it is time for the main activity. The instructions are the same. As each word is presented, categorize it as either imaginary or real as accurately and quickly as possible using the "D" and "K" keys.

D = Imaginary

K = Real

Press the space bar when you are ready for the activity.

### *Reminder Left*

D = Real

K = Imaginary

*Reminder Right*

K = Imaginary

D = Real

*Teleology Instructions*

You will now see a series of one-sentence statements. Rate how much you agree or disagree with each of these statements on the scale provided. Rate them at your natural pace. There is no need to answer quickly. Select your answer by typing a number from 1-6.

1: Strongly Disagree

2: Disagree

3: Slightly Disagree

4: Slightly Agree

5: Agree

6: Strongly Agree

Press space bar to proceed.

*Human Teleology Items*

Alarm clocks beep in order to wake people up.

People wear contact lenses in order to see more clearly.

Bicycles have handlebars so that people can steer them.

Doctors prescribe antibiotics in order to treat infections.

Children wear mittens in the winter in order to keep their hands warm.

People buy microwaves in order to heat their food.

Pencils exist so that people can write with them.

Women put on perfume in order to smell pleasant.

Schools exist in order to help people learn new things.

Stoplights change color in order to control traffic.

People exercise in order to increase physical fitness.

Houses have doorbells in order to make dogs bark.

Window blinds have slats so that they can capture dust.

People chew food in order to strengthen their jaw muscles.

People put coins into meters in order to get rid of spare change.

Tractors have steering wheels so that farmers can drive them.  
People dye their hair black in order to look older.  
Musicians practice their instruments in order to avoid talking.  
Cat food comes in a can in order to fill up recycling bins.  
Lamps shine brightly so that they can produce heat.  
Electricity passes through light bulb filaments in order to make them shine.  
Butter contains a great deal of fat in order to make it greasy.  
Candlewax becomes very hot in order to melt the candle.  
Knives have sharp edges in order to cut through food.  
The main ingredient of lollipops is sugar in order to make them sweet.  
Dryers produce static in order to make clothes cling to each other.  
Computers have keyboards so that people can exercise their hands.

### *Nature Teleology Items*

Bats hunt mosquitoes in order to control over-population.  
Bees frequent flowers in order to aid pollination.  
Birds transfer seeds in order to help plants germinate.  
Mites live on skin in order to eliminate dead skin cells.  
Trees produce oxygen so that animals can breathe.  
Ferns grow at ground level in order to conserve humidity.  
Microbes convert nitrogen in order to enrich the soil.  
Moss forms around rocks in order to stop soil erosion.  
Water exists so that life can survive on Earth.  
Earthworms tunnel underground in order to aerate the soil.  
The fittest animals survive so that species can grow stronger.  
Finches diversified in order to survive.  
Germs mutate in order to become drug resistant.  
Lemurs have adapted in order to avoid extinction.  
Parasites multiply in order to infect a host.  
Molecules fuse in order to create matter.  
Particles collide in order to produce chemical reactions.  
Rain falls in order to allow plants to grow.  
Sand dunes form in order to stop waves eroding vegetation.  
The sun makes light so that plants can photosynthesize.  
The Earth rotates around the sun so that it can receive light.  
Glaciers compact snow in order to conserve volume.  
The Earth has an ozone layer in order to protect it from UV light.



Hurricanes circulate seawater in order to gather energy.  
Lightning releases electricity in order to travel.  
Mountains fold inwards in order to maintain mass.  
Oceans dissolve rocks in order to retain ocean minerals.

*Post-Test Instructions Left*

The next activity is to once again categorize people, places, and things as accurately and as quickly as you can. The instructions are exactly the same as they were before. As each word is presented, categorize it as either real or imaginary as accurately and quickly as possible using the "D" and "K" keys.

D = Real

K = Imaginary

Press the space bar when you are ready for the activity.

*Post-Test Instructions Right*

The next activity is to once again categorize people, places, and things as accurately and as quickly as you can. The instructions are exactly the same as they were before. As each word is presented, categorize it as either real or imaginary as accurately and quickly as possible using the "D" and "K" keys.

D = Imaginary

K = Real

Press the space bar when you are ready for the activity.

### *Theism Check*

Which of these best captures your current beliefs about God, Higher Power, Universal Spirit, etc.? Do you believe it exists, not believe it exists, or are you completely unsure?

Enter a number that describes your beliefs:

1 = I have at least some belief that God exists

2 = I have absolutely no belief that God exists

3 = I am unsure how to answer

### *Data Check*

Please indicate whether your data should be used in this study. If you were unable to focus or otherwise do not want your data used, indicate this below.

1 = The data you provided are quality data that should be used

2 = The data you provided should not be used

### *Exit Page*

This completes the survey. We were interested in why people see nature as having a purpose. One hypothesis is that they automatically sense that nature was intentionally created.

If you have any questions, email [matthew.j.scott@asu.edu](mailto:matthew.j.scott@asu.edu) or [adam.cohen@asu.edu](mailto:adam.cohen@asu.edu). Thank you for your participation.

Pressing space bar will complete the survey and should produce automatic research credit.

APPENDIX B  
COMBINING AND SHAPING THE DATA

The experiment server, Pavlovia, provided a separate CSV for each participant in long form (each row represented a single time point). For each of the four conditions (nature teleology vs. Human teleology and left-hand vs. right hand), the CSVs were merged into a single file that combined all of the long form data vertically. Demographic information from Qualtrics was matched with each participant based on a four-digit number that they entered there and on the Pavlovia part of the study. Each number-match was double checked to have matching times of day on both Qualtrics and Pavlovia. Some participants failed to enter a consistent number on both sites, but the time-match allowed for combining both parts of the data. A few cases had discrepant times and no matching numbers, and thus these cases contain experiment data but no demographic information.

Variables were then created to capture the accuracy of God responses and control responses, with incorrect responses recoded to missing in order to calculate means based on only correct responses (differentiated by theist and atheist correct responses to the God item). Response latencies than 0.2 seconds or longer than 3 seconds were excluded from analyses before removing all responses more than three standard deviations from each within participant mean. The data were then aggregated into a wide form data set that included the “correct-only” means for pre- and post-manipulation target and control items, as well as response accuracy proportions for target and control items.

APPENDIX C  
ANOVA TABLES

Table C1

*Full Teleology X Theism X Time Model (Log-Transformed RT Means)*

Within-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Time	4.146	1	4.146	143.389	<.001	.211
Time*Teleology	.004	1	.004	.135	.714	<.001
Time*Theism	.181	1	.181	6.251	.013	.012
Time*Theism*Teleology	.134	1	.134	4.618	.032	.009
Error (Time)	15.499	536	.024			

Between-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Intercept	149.474	1	149.474	1857.026	<.001	.776
Teleology	.022	1	.022	.272	.602	.001
Theism	2.442	1	2.442	30.343	<.001	.054
Teleology*Theism	.022	1	.022	.270	.604	.001
Error	43.143	536	.024			

Table C2

*Teleology X Time Model (Log-Transformed RT Means)*

Within-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Time	4.587	1	4.587	155.917	<.001	.225
Time*Teleology	.015	1	.015	.520	.471	.001
Error (Time)	15.827	538	.029			

Between-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Intercept	161.621	1	161.621	1907.162	<.001	.780
Teleology	.022	1	.040	.470	.494	.001
Error	45.592	538	.085			

Table C3

*Theism X Time Model (Log-Transformed RT Means)*

Within-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Time	4.143	1	4.143	142.431	<.001	.209
Time*Theism	.193	1	.193	6.630	.010	.012
Error (Time)	15.649	538	.029			
Between-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Intercept	149.680	1	149.680	1864.219	<.001	.776
Theism	2.436	1	2.436	30.335	<.001	.053
Error	43.197	538	.080			

Table C4

*Full Teleology X Theism X Time Model (Response Accuracy Means)*

Within-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Time	.328	1	.328	11.899	<.001	.019
Time*Teleology	.003	1	.003	.096	.757	<.001
Time*Theism	.234	1	.234	8.467	.004	.014
Time*Teleology*Theism	.001	1	.001	.034	.853	<.001
Error (Time)	16.664	604	.028			
Between-Subjects Effects						
Source	Type III SS	df	Mean Sq.	F	Sig.	$\eta_p^2$
Intercept	758.259	1	758.259	5010.710	<.001	.892
Teleology	.118	1	.118	.781	.377	.001
Theism	.475	1	.475	3.141	.077	.005
Teleology*Theism	.283	1	.283	1.871	.172	.003
Error	91.402	604	.151			

APPENDIX D  
HUMAN SUBJECTS APPROVAL





EXEMPTION GRANTED

[Adam Cohen](#)  
[CLAS-NS: Psychology](#)  
480/965-7345  
[Adam.Cohen@asu.edu](mailto:Adam.Cohen@asu.edu)

Dear [Adam Cohen](#):

On 2/23/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Supernatural Agency Detection and the Intuition That Nature is Purposeful
Investigator:	<a href="#">Adam Cohen</a>
IRB ID:	STUDY00013421
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	<ul style="list-style-type: none"> <li>• Dissertation Consent.pdf, Category: Consent Form;</li> <li>• Dissertation IRB Protocol.docx, Category: IRB Protocol;</li> <li>• Dissertation Recruitment.pdf, Category: Recruitment Materials;</li> <li>• Dissertation Study Export.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);</li> </ul>

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 2/23/2021.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

If any changes are made to the study, the IRB must be notified at [research.integrity@asu.edu](mailto:research.integrity@asu.edu) to determine if additional reviews/approvals are required.

Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.

Sincerely,

IRB Administrator

cc: Matthew Scott  
Matthew Scott

Note: The above exemption refers to the original study with undergraduate participants



EXEMPTION GRANTED

[Adam Cohen](#)  
[CLAS-NS: Psychology](#)  
480/965-7345  
[Adam.Cohen@asu.edu](mailto:Adam.Cohen@asu.edu)

Dear [Adam Cohen](#):

On 4/23/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	Supernatural Agency Detection and the Intuition That Nature is Purposeful
Investigator:	<a href="#">Adam Cohen</a>
IRB ID:	STUDY00013421
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	<ul style="list-style-type: none"> <li>• Dissertation (3).pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);</li> <li>• Prolific Consent, Category: Consent Form;</li> <li>• Prolific Recruitment, Category: Recruitment Materials;</li> <li>• Revised Protocol, Category: IRB Protocol;</li> </ul>

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 4/23/2021.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

If any changes are made to the study, the IRB must be notified at [research.integrity@asu.edu](mailto:research.integrity@asu.edu) to determine if additional reviews/approvals are required. Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.

Sincerely,

IRB Administrator

cc: Matthew Scott  
Matthew Scott

Note: The above exempted modification was to collect data through Prolific Academic.