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Anthropocentric Biases in Teleological Thinking: How Nature Seems Designed for Humans

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People frequently see design in nature that reflects intuitive teleological thinking—that is, the order in nature that supports life suggests it was designed for that purpose. This research proposes that inferences are stronger when nature supports human life specifically. Five studies (N = 1,788) examine evidence for an anthro-teleological bias. People agreed more with design statements framed to aid humans (e.g., "Trees produce oxygen so that humans can breathe") than the same statements framed to aid other targets (e.g., "Trees produce oxygen so that leopards can breathe"). The bias was greatest when advantages for humans were well-known and salient (e.g., the ozone layer) and decreased when advantages for other targets were made explicit. The bias was not eliminated by highlighting the benefits for other species, however, and emerged spontaneously for novel phenomena ("Jupiter's gravity protects Earth from asteroids"). We conclude that anthropocentric biases enhance existing teleological biases to see stronger design in phenomena where it enables human survival.

Keywords: teleological thinking, anthropocentrism, intelligent design, egocentrism, explanation

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A common argument for the existence of God is the argument from design, which is that there is an order to life and in the universe that defies random chance, and so appears to have been planned and created by an intentional agent. In his famous watchmaker analogy, for example, William Paley (1802) compared the complexity of nature and the universe with finding a pocket watch on the beach: The intricate mechanisms and precise function of the watch suggests it could not form by mere chance but must be designed for this purpose in mind. But notably, many examples and analogies in support of design refer to phenomena that are important to human survival in particular—from the complexity of the human eye, to the fine-tuning of our universe to support intelligent life (Barrow & Tipler, 1986; Wilson, 1991). We think this is no coincidence but is the product of intuitive anthropocentric biases that enhance teleological reasoning toward human life. Anthropocentric biases can trigger intuitive design thinking by enhancing the relative salience and importance of consequences for our own species. Here we investigate such an *anthro-teleological bias* in the inference of design, where judgments of design in nature are enhanced where it serves human survival compared with that of other species.

Teleology and Design in Nature

There is something genuinely compelling to the argument from design—how else could something both complex and useful (whether a pocket watch, an eye, or a universe) come about by accident? Design arguments are compelling because they draw on deep-rooted social–cognitive biases that connect agents with goals and actions (Kelemen, 2004). In particular, design arguments employ teleological thinking (from the Greek *telos*, meaning end or purpose), where events that serve a critical function (e.g., a universe that supports intelligent life) are perceived as intended for that purpose (Dennett, 1987). Adopting a teleological stance helps us to quickly interpret the functions of manmade objects, for example, understanding that a fishing rod was designed for the purpose of catching fish, but is also readily applied to natural phenomena when it is not scientifically warranted (Kelemen, 1999, 2004). For example, young children might describe rocks as "for" sitting and mountains as "for" climbing (Kelemen, 1999), though these uses are unrelated to how (or why) they were made. If an end-state serves a function, even incidentally, it is easily perceived as for that purpose (Gergely & Csibra, 2003). This overt teleological reasoning declines as we mature (Kelemen & Rosset, 2009) but remains a default cognitive stance in adulthood (Lombrozo, Kelemen, & Zaitchik, 2007), even among those with formal scientific training (Kelemen, Rottman, & Seston, 2013).

Teleological reasoning therefore lends itself to seeing design in nature, including biological processes such as evolution (Tennant, 1928), where outcomes often serve important and specific func-

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tions to support life (Lombrozo & Carey, 2006; Lombrozo & Rehder, 2012). For example, polar bears' thick fur keeps them warm in winter, an adaptation the result of thousands of generations of bears who lived or died in cold weather. But it is much easier to think the thick fur evolved to keep bears warm than as the whittling-down of random variations that is involved in natural selection. Indeed, evolution is commonly misunderstood as a directed process toward solving problems of survival (Gould, 1996; Shtulman, 2006). Teleological thinking is not limited to thinking about biology, however, but can be used to interpret any natural phenomena that are uniquely configured to support life, such as Earth's ozone layer that protects humans and other species from deadly radiation. Although evolutionary adaptations are typically self-serving (e.g., fur is an advantage to the bear herself), nonbiological phenomena with teleological implications are usually other-serving, meaning that the implied purpose is to aid another target (Keil, 1992; Kelemen, 2003). Teleological judgments might be considered scientifically unwarranted here (Casler & Kelemen, 2008), yet some prominent examples of teleological thinking toward nature are seen to serve other targets (Sagan, 1973).

Anthropocentrism in Teleological Thinking

One of the most important cues for judgments of design is the appearance of *fine-tuning*—that is, there is a special configuration in nature that is uniquely suited to support life (Dembski, 2004). Intelligent design theory makes frequent reference to fine-tuning and defines it as a "specified complexity" (Dembski, 2004): If conditions are arranged in a way that is especially unlikely, complex, and beneficial, it cannot arise from chance but must be by design. For example, Earth is located in the Goldilocks Zone (Ward & Brownlee, 2000), so-called because its distance from the Sun appears perfectly fine-tuned ("just right") to support life. The quintessential example of fine-tuning is the anthropic cosmological principle (Barrow & Tipler, 1986; Carter, 1974). In brief, the anthropic principle notes that that our universe possesses numerous precise laws of nature and conditions (e.g., the gravitational constant, the mass of a proton), and even a small deviation from these values would make the evolution of life impossible (e.g., stars and galaxies could not form). The fact that we do exist therefore demonstrates just how special our universe is.

Notably, the design arguments underlying the anthropic principle and the Goldilocks Zone cite phenomena that benefit humans in particular (Bostrom, 2013; Manson, 2000); for instance, the anthropic principle is based on the astronomical improbability of a universe that supports intelligent life, like humans (hence, *anthropic*). We argue here that anthropocentrism enhances teleological thinking where it serves human life for two possible reasons. First, anthropocentrism (like egocentrism; Ross & Sicoly, 1979) anchors us in our own perspective so that we are ignorant to the experiences of other species. So, whereas the value of a natural phenomenon is obvious when it applies to us, we may not even perceive the same advantages for others. This also implies that we can reduce anthro-teleological bias by highlighting the advantages and means of survival for other targets. Indeed, the argument for intelligent design has been criticized for a "lack of imagination" (Dawkins, 1986; Sagan, 1973) or failure to appreciate counterfactual possibilities that include very different forms of life than our own. Carl Sagan (1973) identified "carbon chauvinism" as a form of egocentric bias where it is assumed carbon is crucial for life, just because we are carbon-based lifeforms (see also "temperature chauvinism," "oxygen chauvinism"; Sagan, 1973). This is particularly relevant for the judgment of outcomes as fine-tuned (Bostrom, 2013). We may interpret the fact that Earth is the optimal temperature for human life as evidence of fine-tuning, for example, but fail to consider how some lifeforms thrive in temperatures much warmer or colder than we are used to.

Second, anthropocentric biases inflate the perceived importance of consequences for humans relative to other species. We intuitively elevate humans above other animals, especially in capacities of mind and agency (Haslam & Loughnan, 2014; Morewedge, Preston, & Wegner, 2007), seeing ourselves as smarter and more sophisticated than our beastly cousins. Anthropocentric biases shape how we see other animals (Carey, 1985); when we do attribute mind to other species, it is usually because we have anthropomorphized the targets, imputing qualities reserved only for humans (Eddy, Gallup, & Povinelli, 1993; Waytz, Gray, Epley, & Wegner, 2010). Indeed, the idea that humans are superior to other species is pervasive in our culture and a difficult mindset from which to break free. This is apparent in the common misunderstandings of evolution by natural selection (Evans, & Lane, 2011; Shtulman, 2006). One of the more radical implications of Darwinian evolution was that humans are just another branch in a tree of life, no more or less than any other species adapted to its environment (Darwin, 1859). Yet humankind is often depicted as the pinnacle of evolution—the top rung in the "great chain of being" (Hodos & Campbell, 1969; Lovejoy, 1936). We view our own species as not just specialized, but as special, and so too are the circumstances on which our lives depend. And so, anthropocentrism can promote the idea that nature is somehow directed toward our survival. Human life is inherently valuable, and so when nature conspires to create conditions just right for human life, it seems only natural it was designed for humans in particular.

Present Research

These five studies investigate an anthro-teleological bias in inferences to design in nature. In all studies we compared teleological statements directed toward humans (e.g., "Trees produce oxygen so that humans can breathe") to the same phenomena directed to a nonhuman target (e.g., "Trees produce oxygen so that leopards can breathe"). Important, we selected only natural phenomena that were other-serving (rather than self-serving), (Keil, 1992; Kelemen, 2003) and many nonbiological phenomena (e.g., the ozone layer). According to Keil (1992) , teleological explanations can be applied to biological organisms where there is a self-serving adaptation, as in natural selection. For example, the claim that organisms develop fever when sick to kill off infection is a scientifically warranted teleological explanation, although the organism is neither aware nor intends to do this. The adaption developed for the very reason that it enabled its own survival, and so teleological explanations are justified here. But in our studies, we purposely selected nonbiological natural phenomena that were other-serving, rather than self-serving, and so are not valid teleological explanations. For example, Jupiter's massive gravity attracts comets and asteroids that could otherwise collide with Earth; but protecting life on Earth has no consequence for Jupiter. In this sense, it is illogical to support the idea that Jupiter's gravity

developed "for" humans or other life on Earth. Here, teleological judgments have no scientific or logical rationale, so design inferences should a reflect deep intuitive biases to explain the phenomena as purposeful.

We test three predictions. First and foremost, we expected to find evidence for an anthro-teleological bias, that is, stronger inferences to design in nature where it supports humans, relative to other targets. Our further predictions test the underlying causes and boundaries of the anthro-teleological bias. A key characteristic of egocentrism is biased perspective, similarly anthropocentrism might enhance teleological thinking toward humans through greater awareness of how nature benefits humans. However, increased attention to how those same benefits to others might reduce this effect. Our second prediction, therefore, is that an anthro-teleological bias may be reduced by making benefits to nonhumans more salient and explicit. In addition to greater salience of outcomes for humans, anthropocentrism may also affect the relative value of those outcomes. That is, the implications of natural phenomena for human survival carry greater significance and importance than implications for other species, equally affected by the same phenomena. This would be supported by a spontaneous anthro-teleological bias for phenomena that helps both humans and nonhumans. We predict that people will spontaneously support more teleological statements for humans versus other targets when presented with new information about a natural phenomenon that is implied to support human and nonhuman life.

Study 1: Evidence for Bias in Teleological Thinking Toward Humans

Study 1 provided an initial test of an anthropocentric bias in teleological reasoning. Participants responded true or false to a series of causal and teleological statements, including some that described a natural phenomenon as developing to support either humans or another target. We predicted that design statements will be endorsed more often when it is directed toward human survival.

Method

We report the results of five studies and include all conditions and variables measured. All participant exclusions are reported. All studies were conducted online and approved by Institutional Review Board protocols at the University of Illinois at Urbana–Champaign.

Participants. We aimed to collect data from at least 70 participants per condition to observe a medium effect size ($f = .25$) at 80% power in a between-subjects design. One hundred thirty-seven people were recruited on Amazon Mechanical Turk (MTurk) for a small fee (M age = 34.5 years; 78 women, 59 men; 49% Christian; 45% nonreligious; <6% Jewish, Buddhist, other; 0.7% nonreporting).

Procedure. Participants were randomly assigned to either a human-design or other-design condition and responded true/false to 34 statements presented in random order. Following the design of Kelemen and Rosset (2009), 20 statements served as control items read in both conditions. These statements consisted of true-causal (TC) statements (e.g., "Objects fall downwards because they are affected by gravity"), false-causal (FC) statements (e.g., "Polar bears are white because they swim in icy ocean water"), true-teleological (TT) statements (e.g., "Children wear mittens in the winter in order to keep their hands warm"), and false-teleological (FT) statements (e.g., "Houses have doorbells in order to make dogs bark"). Note that both TT and the FT statements refer to a purpose or intention that is outside of nature or biological processes, and so not directed by typical intelligent design thinking. Fourteen design statements written for this study were also included that described a natural phenomenon that enables life. In the human-design condition, the design statements described a natural phenomenon with an implied design to humans (e.g., "Trees make oxygen so that people can breathe"). In the nonhuman design condition, the statements implied a design for a nonhuman target (e.g., "Trees make oxygen so that leopards can breathe"; see Table 1). Of these 14 items, four items described phenomena that affected Earth or another planet (e.g., "Sun produces heat and energy so to keep Earth [Venus] warm"). Following all statements participants were asked demographic information, including whether they were religious (yes/no), and debriefed.

Results

Agreement by statement type. For analysis, agreement with all 34 items were coded 1 for true and 0 for false. Mean agreement

Table 1
Percentage Agreement With Teleological Statement by Condition

Design statement	Human	Nonhuman
Earth has an ozone layer to protect people [giraffes] from harmful radiation.	63%	37%
The moon orbits the Earth to provide humans [wolves] with a stable climate.	31%	23%
Earth is near the Sun so that humans [monkeys] can receive warmth.	43%	25%
The Sun makes light so that people [bears] can see.	47%	23%
The Earth rotates every 24 hours to regulate the temperature for humans [goats].	24%	12%
The Earth has water so that humans [horses] can survive.	50%	28%
Fruits are high in vitamin C so that people [squirrels] can be healthy.	49%	6%
Trees make oxygen so that people [leopards] can breathe.	63%	30%
Water evaporates and then precipitates so to provide people [dogs] with fresh water.	43%	22%
The atmosphere is 20% oxygen so that humans [foxes] can live.	46%	10%
Earth [Saturn] orbits the Sun once a year so that it can have seasons.	46%	25%
Jupiter's gravity attracts asteroids to protect Earth [Mars] from collisions.	31%	25%
Supernovas exploded long ago so that metals could later form on Earth [Mars].	32%	21%
Sun produces heat and energy so to keep Earth [Venus] warm.	63%	20%

and error rates were calculated for each category of statements. As expected, mean agreement for true statements was high (TC items: $M = 97\%$, $SD = .10$; TT items: $M = 98\%$, $SD = .11$), and mean agreement for false statements was low (FC items: $M = 13\%$, $SD = .22$; FT items: $M = 11\%$, $SD = .19$). For our purposes here, we distinguish between ordinary teleological statements (e.g., "People wear contact lenses in order to see more clearly") and design teleological statements (e.g., "Earth has water so that horses can survive"), with the design statements directed to either humans or another target. Overall participants endorsed a third of the design items, regardless of target ($M = 33\%$, $SD = .37$), more than either FT items (repeated-measures analysis of variance [ANOVA]), $F(1, 136) = 79.11$, $p < .001$, $\eta_p^2 = 0.37$, 95% confidence interval (CI) [0.26, 0.46], or FC items, $F(1, 136) = 43.66$, $p < .001$, but less than TC or TT items, $F(1, 136) = 69.62$, $p < .001$.

Anthro-teleological bias. To test the primary hypothesis that teleological thinking is stronger toward human targets, mean endorsement of design statements was analyzed by two-group between-subjects ANOVA. Results illustrated a robust anthropocentric bias, $F(1, 135) = 22.38$, $p < .001$, $d = .81$. More design statements were endorsed for human targets ($M = 45\%$, $SD = .34$) compared with nonhuman targets ($M = 20\%$, $SD = .26$; see Table 1). Of the 14 design items, 10 items described a phenomenon where the implied design was directed toward a particular species (humans vs. another animal), and four items described a phenomenon where the implied design was toward a planet (Earth vs. another planet). We reasoned that the anthro-teleological bias should extend to a geocentric bias as Earth is our home planet, and results supported this prediction. Mean agreement with teleological statements was nearly identical for items describing species ($M = 46\%$, $SD = .36$) versus planets ($M = 45\%$, $SD = .34$). We compared the magnitude of the anthro-teleological biases with a 2 (design target: humans/other) $\times$ 2 (items: anthrocentricc/geocentric) ANOVA with repeated measures on the second factor and found no difference, $F(1, 135) = .80$, $p = .37$, $\eta_p^2 = .006$. The bias was equivalent for the statements that were exclusively focused on human/nonhuman targets, $F(1, 135) = 19.56$, $p < .001$, $d = .80$, and for Earth/extraterrestrial targets, $F(1, 135) = 18.40$, $p < .001$, $d = .74$.

Religion and teleological reasoning. Religious people have been shown to rely on more intuitive judgments (Shenhav, Rand, & Greene, 2012) and use more intentional and teleological explanations (Banerjee & Bloom, 2014). We therefore examined how religious belief may relate to causal and teleological judgments. We can look at differences in judgment by calculating the error rate for each of the statement categories and the overall error rate. Religiousness was dummy coded (0 = none; 1 = religious) based on affiliation data. Error rates were analyzed with a 2 (religion) $\times$ 2 (design condition: human/other) multivariate analysis of variance (MANOVA). Over all statement types, religious people made more errors (9.7%) than did nonreligious people (4.5%), $F(1, 132) = 7.36$, $p = .008$, $d = .48$. On the target design items, religious people agreed more (41%) than did nonreligious people (23%), $F(1, 132) = 9.12$, $p = .003$, $d = .54$. Moreover, this effect of religion on design items held when controlling for overall error rate, $F(1, 131) = 4.93$, $p = .028$, $\eta_p^2 = .036$. In other words, religious people showed higher overall endorsement of design in general, but this was not due to being more error prone. Further, though religious people did endorse more design statements, there was no Religion $\times$ Target interaction ($F < 1$), meaning the size of the anthro-teleological bias was equivalent for religious and nonreligious people.

Summary

Study 1 provided initial evidence for an anthro-teleological bias. Participants endorsed more design statements when the implied purpose was to benefit humans, compared with the same statements framed to help other targets. This shows how design inferences can be applied selectively. Indeed, we can hold different kinds of explanations simultaneously (Legare & Shtulman, 2018), ready to interpret phenomena using either teleological or nonteleological explanations. But anthropocentrism may enhance tendencies to see design in nature when it helps humans. These results show judgments bend more toward design when there is a benefit to human survival.

Study 2: Anthro-Teleological Bias Is Not Deliberately Controlled

Study 1 provided initial evidence for the anthro-teleological bias. Study 2 aimed to replicate these findings and examine the extent that the bias is effortfully controlled. As in Study 1, participants responded true or false to a series of causal and teleological statements, including some design statements that described a natural phenomenon as serving either humans or another target. We also included a time pressure condition (between-subjects) to induce cognitive load. Prior work has shown that time pressure can increase general teleological thinking, (e.g., Kelemen & Rosset, 2009; Kelemen et al., 2013) suggesting teleological thinking is an intuitive bias that is effortfully controlled. We expected to replicate the anthro-teleological bias in both speeded and unspeeded conditions (greater design attributed for humans than nonhumans). We did not make an a priori prediction about the effects of time pressure on the anthro-teleological bias, however the results can help clarify the extent that the bias operates under conscious control. If the bias does increase under time pressure (i.e., people become more likely to attribute design toward humans relative to other targets), this would suggest that cognitive resources are used to adjust tendencies to attribute design toward humans. If we see no effect of time pressure on the size of the bias, this implies that the bias is not effortfully controlled when cognitive resources are available. This study follows the design of Study 1 using several statements that participants responded to as true/false, including some nature-design items where there was an implied design toward either humans or a nonhuman target. We included a between-subjects time pressure condition in which participants were told to answer questions as quickly as possible.

Method

Participants. We aimed to collect data from at least 300 participants to observe a medium effect ($f = .25$) at 95% power in a four-group between-subjects design. Three hundred three people were recruited on Amazon MTurk for a small fee (M age = 38.8 years; 151 women, 150 men, two nonreporting; 49% Christian; 42% nonreligious; <7% Jewish, Hindu, Buddhist, other; 3% nonreporting).

Procedure. Participants were randomly assigned one of four conditions in a 2 (design target: human/other) × 2 (time pressure) between-subjects design. The overall design and items followed Study 1, including TC statements, FC statements, TT statements, and FT statements. We included eight design in nature statements used in Study 1 (e.g., "Trees make oxygen so that people can breathe") but dropped design items focused on Earth/other planets to focus on anthropocentric items. Participants in both conditions were told their task was to answer 28 true or false questions. In the time pressure condition, participants were instructed we were looking at how many questions they can answer correctly in under 2 min, and questions automatically advanced when participants clicked true or false. Following all statements participants were asked demographic information, including religious affiliation, and debriefed.

Results

Agreement by statement type. For analysis, agreement with all 28 items were coded as 1 for true and 0 for false. Mean agreement and error rates were calculated for each category of statements. As expected, mean agreement for true statements was high (TC items: $M = 92\%$, $SD = .17$; TT items: $M = 93\%$, $SD = .17$), and mean agreement for false statements was low (FC items: $M = 23\%$, $SD = .29$; FT items: $M = 21\%$, $SD = .28$). As in Study 1, we distinguish between ordinary teleological statements (e.g., "People wear contact lenses to see more clearly") and design teleological statements (e.g., "Earth has water so that horses can survive"). Overall participants endorsed almost half of the design items ($M = 46\%$, $SD = .38$), more than either FT items (repeated-measures ANOVA), $F(1, 301) = 145.08$, $p < .001$, or FC items, $F(1, 301) = 109.92$, $p < .001$, but less than TC, $F(1, 301) = 331.45$, $p < .001$, or TT items, $F(1, 301) = 371.71$, $p < .001$.

Time pressure. Total time participants spent on the task was recorded and analyzed by a one-way ANOVA by time pressure condition. Participants finished more quickly under time pressure ($M = 3$ min, 42 s) compared with no time pressure ($M = 4$ min, 37 s), $F(1, 301) = 4.09$, $p = .044$, suggesting the time pressure manipulation was effective. Effects of time pressure on responses were analyzed by a one-way ANOVA. Time pressure did not affect responses to either TC ($F < 1$), TT ($F < 1$), or FC statements, $F(1, 301) = 1.28$, $p = .26$. For FT statements, there was more agreement under time pressure ($M = 24\%$ $SD = .29$) than without ($M = 18\%$ $SD = .26$), but this was above significance threshold, $F(1, 301) = 1.28$, $p = 056$.

Anthro-teleological bias. Teleological thinking was analyzed by 2 (target: human/other) × 2 (timed) design. As in Study 1, results supported an anthropocentric bias, $F(1, 298) = 38.11$, $p < .001$. More design statements were endorsed on human items ($M = 59\%$, $SD = .35$) compared with other items ($M = 33\%$, $SD = .36$). But there was no effect of time pressure on design items nor an interaction between design target and time pressure (Fs < 1), and time pressure did not affect mean agreement for either human-design or other design statements.

Religion and teleological reasoning. As in Study 1, we examined how religiousness may predict stronger teleological thinking. Religiousness was dummy coded (0 = none/1 = religious) based on affiliation data. On the design items, error rates were analyzed with a 2 (religion) × 2 (design condition: human/other) MANOVA. Religious people agreed with more design statements (51%) than nonreligious people (37%), $F(1, 290) = 7.76$, $p = .006$, $\eta_p^2 = .026$. However, there was no Religion × Target interaction ($F < 1$). Though religious people did endorse more design statements, the anthro-teleological bias was equivalent for religious and nonreligious people.

Discussion

Study 2 replicated results of Study 1 and provided further evidence for an anthro-teleological bias in judgments of design. Participants endorsed more design statements when the implied purpose was to benefit humans, compared with the same statements framed to help other targets. Study 2 also examined anthro-teleological thinking under a cognitive load condition, using a time pressure manipulation. In previous studies, time pressure increased agreement with teleological reasoning (e.g., Kelemen & Rosset, 2009; Kelemen et al., 2013), indicating that the tendency toward teleological thinking is adjusted by conscious attention. Time pressure increased endorsement for ordinary false teleological statements (e.g., "Mice run away from cats in order to get exercise"), though the effect was above significance threshold ($p = .056$). But time pressure did not enhance agreement with anthro-teleological statements (e.g., "The Sun makes light so that people can see") and did not further increase the gap between human and nonhuman teleological thinking. This suggests that the anthro-teleological bias is not corrected through deliberate controlled processes. This is perhaps not surprising, as the difference between human and nonhuman teleology is already quite large in the unspeeded condition, making it difficult to increase the size of the effect in time pressure condition. But this does necessarily mean that it not a bias in the true sense. We observe a strong asymmetry in teleological thinking toward humans, which reflects a bias in teleological judgment, even without cognitive control. There are other cognitive biases that are expressed without cognitive control because they effectively distort intuitive judgment (Tversky & Kahneman, 1983). Likewise, the fact that anthro-teleological thinking appears independent of cognitive resources implies how pervasive and intuitive anthropocentric effects are. Indeed, the size of the anthro-teleological bias under unspeeded conditions suggests there is little effort to control the bias even under conscious awareness. In subsequent studies we further examine the automaticity, whether in can be adjusted through attention to other targets, and if we observe the bias spontaneously for novel phenomena.

Study 3: Salient Benefits to Another Species

Studies 1 and 2 provided evidence that people see greater design in nature toward humans than for nonhumans. One reason for this anthro-teleological bias may be observer effect: humans may be privileged targets of design attributions because we simply know more about humans than nonhuman animals (Heyman, Phillips, & Gelman, 2003). On an individual level, egocentric biases can enhance focus on how outcomes affect oneself, and when there is a benefit to everyone, people overestimate advantages for oneself (Windschitl, Kruger, & Simms, 2003). Practice with perspective taking can adjust egocentric biases, however (Epley, Morewedge, & Keysar, 2004). Similarly, Study 3 tested whether the anthro-teleological could be adjusted by increasing salience of shared

benefits to nonhumans. We selected a natural phenomenon where people should be familiar with the benefits to humans but not necessarily for other targets: UV protection by the ozone layer. In Study 1, an item on the ozone layer showed the greatest anthro-teleological bias, with 63% agreeing that the ozone layer developed in order to protect humans from harmful radiation, compared with only 26% who agreed it developed to protect to nonhuman target (giraffes). Participants read a brief scientific description of ozone and its development that highlighted the positive consequences for (1) humans, (2) giraffes, or (3) did not mention any benefits. We expected greater agreement that the ozone layer developed to protect humans than to protect giraffes. This bias should be reduced when the benefit to the other target (giraffes) is made salient. But we do not expect to eliminate the bias entirely. Even when it should be known the advantages are not limited to humans, people may still preferentially apply design thinking toward human life.

Method

Participants. We aimed to collect a minimum of 120 participants (less exclusions) to observe a medium effect size ($f = .25$) at 80% power in a mixed ANOVA. All participants were recruited on MTurk for a small fee. Four hundred fifty-one people were recruited with 14 omitted for duplicate IP addresses, leaving 438 (M age = 36.7 years; 194 women, 239 men, one other, four nonreporting; 51% Christian; 37% no affiliation; <10% Jewish, Muslim, Hindu, Buddhist, other; 2.7% nonreporting).

Procedure. Participants were randomly assigned to one of six conditions in a 3 (benefit: human/other/control) × 2 (likelihood: low/high) between-subjects design. In all conditions, participants read a description of how the ozone layer developed. Though not part of our primary hypotheses, we manipulated whether the development of the ozone layer was framed as only somewhat unlikely (one in five chance) or extremely unlikely (one in 5 trillion chance), as fine-tuning arguments often rely on highly improbable outcomes. To test our primary hypothesis, the apparent benefits of the ozone layer were framed as helping either humans, other targets, or no benefits were described. In the no-benefit condition, the passages did not include any explicit mention of the benefits of the phenomena. In both benefit conditions, the description explicitly illustrated the benefits of the phenomenon. In the human-benefit condition, the ozone layer was described as protecting humans from UV radiation.

Measures. Before the target dependent measures, two multiple-choice questions asked participants to recall factual details about the formation of ozone the statistical probability provided in the description. Participants next rated on seven-point Likert scales (endpoints 1 = *not at all* 7 = *extremely*) (1) subjective probability of the ozone layer developing on three items (how likely was the development, how certain, how many factors could disrupt its natural development), (2) subjective value on two items (how good, how important), and (3) how "lucky" the development of the ozone layer was.

Participants responded to teleological statements framed toward humans and other targets in a repeated-measure design. Participants rated their agreement of whether the ozone layer developed to protect humans and giraffes, on two respective seven-point scales (endpoints 1 = *not at all* 7 = *strongly*). Participants next completed a five-item religiosity scale (e.g., "I consider myself to be a religious person"). To check the prior familiarity with the phenomenon, participants in both studies were asked two questions: (1) "Before this study, did you know about the ozone layer?" (rated on a seven-point scale, endpoints: 1 = *not at all familiar*; 7 = *very familiar*) and "Before this study, did you know that the ozone layer absorbs harmful UV radiation?" (yes, no, unsure). Finally, participants were asked demographic information including religious affiliation, and debriefed.

Results

Prior knowledge. As expected, participants reported strong familiarity with the ozone layer and its benefits prior to the study. For general familiarity with the ozone layer, participants were well above the midpoint of the seven-point scale ($M = 5.38$, $SD = 1.46$), $t(437) = 21.28$, $p < .001$. The majority of participants (79.5%) answered in the affirmative that they were aware that "the ozone layer absorbs harmful UV radiation" before participating in the study.

Subjective probability, subjective value, and luck. For brevity, analyses of these variables in Studies 3 through 5 are discussed in the online supplementary material.

Teleology. As a test of our primary hypotheses, responses to the teleology questions in Study 3 were analyzed by a 3 (benefit: humans, other, control) × 2 (likelihood) × 2 (design target: human/giraffe) mixed ANOVA with repeated measures on last variable. See means in Figure 1. There was a main effect of design target, showing the predicted anthro-teleological bias: $F(1, 432) = 117.85$, $p < .001$, $\eta_p^2 = .21$, 95% CI [0.15, 0.28]. Participants were more likely to endorse the design statement for humans ($M = 4.53$, $SD = 2.21$) than for giraffes ($M = 3.29$, $SD = 2.24$) across all conditions. There was no main effect of likelihood condition, $F(1, 32) = 2.15$, $p = .14$. The Likelihood × Benefit interaction was significant, $F(2, 432) = 3.43$, $p = .03$, but this interaction was not predicted and did not fit any meaningful pattern. The main effect of benefit was nonsignificant ($F < 1$). But more important, the predicted Benefit × Design interaction was significant, $F(2, 427) = 7.65$, $p < .001$, $\eta_p^2 = .034$ [0.01, 0.07], demonstrating the anthro-teleological bias varied by whom the outcome seemed to benefit. Difference scores were calculated to measure the size of the bias in each condition, and pairwise comparisons found the

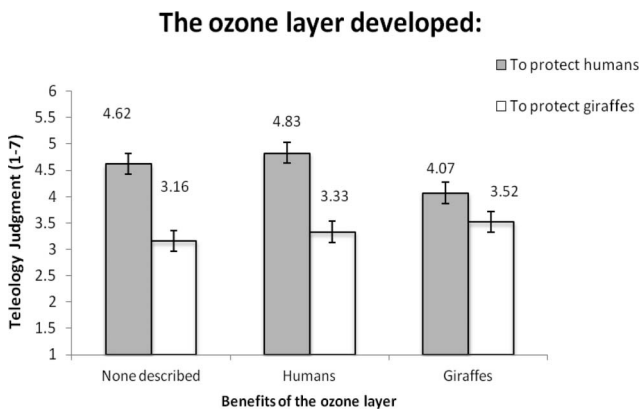

Figure 1. Anthro-teleological bias: Study 3.

bias was significantly smaller in the giraffe-benefit ($M = .52$, $SD = 1.92$) condition compared with both the control condition ($M = 1.50$, $SD = 2.24$; $p < .001$) and human-benefit condition ($M = 1.47$, $SD = 2.21$; $p < .001$), but the bias was not different between the control and human-benefit conditions ($p = .89$). Reading about the benefits of the ozone layer for giraffes reduced the anthro-teleological bias but did not eliminate it and reading about the benefits to humans did not increase the bias above baseline. This overall pattern suggests that the knowledge of benefits of the ozone layer for humans was accessible prior to the study, and this anchored relative design judgments toward humans.

Religion and teleological thinking. We also analyzed the role of religious belief in teleological thinking. Keeping with Study 1, religion was dummy coded (none = 0; religious = 1) based on religious affiliation data. Means for ozone teleology were analyzed by 3 (benefit) × 2 (religious: yes/no) × 2 (design: humans/nonhuman) with repeated measures on last variable. There was a main effect of religion on teleological thinking, $F(1, 420) = 34.70$, $p < .001$, $\eta_p^2 = .076$, 95% CI [0.03, 0.12], with religious people endorsing more teleological statements in general. Moreover, Religion × Design interaction was significant $F(1, 420) = 8.35$, $p = .004$, $\eta_p^2 = .019$. Both religious and nonreligious people inferred greater design toward humans, but the bias was larger among religious people.

Discussion

Study 3 provided further evidence for an anthro-teleological bias for the ozone layer as a natural phenomenon known to benefit humans. Though the ozone layer provides UV protection to all life on Earth, participants expressed more agreement with the statement the ozone layer developed to protect humans than the same statement about giraffes. Important, the bias toward humans was as strong in the control condition (when no benefits to humans were mentioned) as in the Human-Benefit condition, suggesting a preexisting bias toward humans. This could be partly explained by preferential knowledge about the consequences to our own species. The ozone layer is well-known to provide UV protection to humans, but these same benefits may be less well-known for other animals. Indeed, the size of the bias was reduced by describing benefits of the ozone layer for giraffes. Yet, the bias was not entirely eliminated in the giraffe-benefit condition, suggesting the effects of anthropocentrism are not just due to perspective-taking issues.

One issue with the present study is the particular use of giraffes as a comparison, both in the conditions, and the teleological items. In the Giraffe condition, highlighting benefits for giraffes could imply there was something special about giraffes compared with other animals. And in all conditions, asking about humans and inflating the bias. Of course, that there should be any difference between the two reflects an anthropocentric bias in itself. But we address these issues in the next study by highlighting benefits to a general category of animals and asking teleological items about several different species.

Study 4: Salient Benefits to Many Species

Study 3 found inferences to design for the ozone layer were stronger toward protecting humans than a specific nonhuman target (giraffes). But the bias was reduced after describing the benefits of the ozone layer for giraffes. Study 4 extends these findings by highlighting benefits to a larger category of targets ("land-dwelling animals"). As in Study 3, this tests whether decreasing focus toward human outcomes (by highlighting the benefits to nonhumans) reduces anthro-teleological bias. But Study 4 has two significant improvements over Study 3. First, Study 4 includes a condition that describes general benefits of the ozone layer for a group of targets, rather than highlighting for one particular nonhuman target. Important, this larger category includes humans but is not exclusive to humans, and neither humans not any other species are mentioned. This reflects how natural phenomena typically affect multiple targets in a similar way, but we may attend more to consequences for humans. As in Study 3, we expect this manipulation to reduce the anthro-teleological bias. If there is still stronger design toward humans here, it would suggest the intuition to apply design to humans is not merely due to biased knowledge about benefits. Second, whereas participants in Study 3 made teleological judgments for only humans and giraffes, participants in Study 4 were asked about several different targets. The particular comparison with giraffes in Study 3 may have stuck out as unusual, set up a stronger contrast between the two. But the present study used five different (and relatively ordinary) targets that serve as a collective generic comparison between nonhumans to humans and there is no particular contrast between humans and any single target.

Method

Participants. 499 participants were recruited for a small payment on MTurk. Data from eight participants were omitted for duplicate IP addresses for a total of 491. (M age = 35.6 years; 244 women, 237 men, two other, seven nonreporting; 43.6% Christian; 45.4% nonreligious; 10.3% Jewish, Muslim, Hindu, Buddhist, and other; 0.6% nonreporting.)

Procedure. The design of Study 4 closely followed the design of Study 3. As in Study 3, all conditions (control, human-benefit, general-benefit) described how ozone formed in the Earth's atmosphere. The human-benefit condition also described specifically how the ozone layer protected humans from deadly UV. The general-benefit condition described the ozone layer as protecting "land-dwelling animals" from deadly UV, a category inclusive but not exclusive to humans. Participants responded to teleological statements framed toward humans and five other targets in a repeated-measure design. Participants rated their agreement of whether the ozone layer developed to protect humans, pigs, dogs, birds, cows, and giraffes, on six respective seven-point scales, in randomized order. Participants were next given three measures of religious attitudes: (1) a four-item scale to assess general intelligent design beliefs (e.g., "The Universe is fine-tuned so that life can exist and flourish"), (2) a nine-item scale on Belief in an intervening God (e.g., "I believe God is personally involved in my life"), and (3) a five-item religiosity scale (e.g., "I consider myself to be a religious person"). To check the prior familiarity with the phenomenon, participants in both studies were two questions: (1) "Before this study, did you know about the ozone layer?" (seven-point scale) and (2) "Before this study, did you know that the ozone layer absorbs harmful UV radiation?" (yes, no, unsure).

Finally, participants were asked demographic information, including religious affiliation, and debriefed.

Prior knowledge. As expected, participants reported strong familiarity with the ozone layer and its benefits prior to the study. For general familiarity with the ozone layer, participants were well above the midpoint of the seven-point scale ($M = 5.52$, $SD = 1.37$, $t(490) = 24.39$, $p < .001$), and the majority of participants (81%) answered in the affirmative that they were aware that "the ozone layer absorbs harmful UV radiation" before participating in the study.

Teleology. Here we asked design questions for humans and five nonhuman targets (pigs, dogs, birds, cows, giraffes). We confirmed there were no differences in teleological judgment between these five targets, using a five-level repeated-measures ANOVA, $F(4, 476) = .36$, $p = .84$. We calculated mean teleology for all nonhuman targets ($\alpha = .97$). Responses to teleology items were analyzed by a 3 (benefit: control/human/general) × 2 (likelihood) × 2 (design bias: human/other) mixed MANOVA with repeated measures on last variable. See means Figure 2. There was a main effect of design showing a robust anthropocentric bias, $F(1, 485) = 151.76$, $p < .001$, $\eta_p^2 = .24$, 95% CI [0.18, 0.29]. Participants were more likely to endorse the teleological statement for humans ($M = 4.19$, $SD = 2.40$) than for other animals ($M = 3.25$ $SD = 2.07$) across all conditions. There was no main effect of likelihood condition, $F(1, 485) = 2.02$, $p = .16$, or any interaction with likelihood and other conditions on judgments (Fs < 1.63, ps > .20). There was a main effect of benefit condition, $F(2, 485) = 6.22$, $p = .002$, $\eta_p^2 = .025$, 95% CI [0.01, 0.05], qualified by a significant Design × Benefit interaction, $F(2, 485) = 31.45$, $p < .001$, $\eta_p^2 = .11$, 95% [0.07, 0.16]. Although an anthro-teleological bias was observed in all benefit conditions, the size of the bias varied. The bias was strongest in human-benefit condition, where only benefits to humans are described, $F(1, 165) = 100.73$, $p < .001$, $\eta_p^2 = .38$, 95% CI [0.28, 0.46], ($M_{human} = 4.57$, $SD = 2.46$; $M_{nonhuman} = 2.86$, $SD = 1.84$). Anthro-teleological bias was also present in the control condition, where no benefit to humans or other animals was explicitly mentioned, $F(1, 152) = 36.98$, $p < .001$, $\eta_p^2 = .196$, 95% CI [0.11, 0.28], ($M_{human} = 3.66$, $SD = 2.46$; $M_{nonhuman} = 2.95$, $SD = 1.91$). Anthro-teleological bias was smallest in general-benefit condition, $F(1, 168) = 16.71$, $p < .001$, $\eta_p^2 = .09$, 95% CI [0.03, 0.16], where the ozone layer was described as essential to survival of "land-dwelling animals" ($M_{human} = 4.30$, $SD = 2.46$; $M_{nonhuman} = 3.95$, $SD = 2.24$). Notably, this condition also had high endorsement for human teleology item, like the human-benefit condition, but there was also more endorsement for the nonhuman animals compared with other conditions. The anthro-teleological bias was reduced, but not eliminated. People still preferentially applied teleological thinking that the ozone layer was "for" people, compared with other land animals.

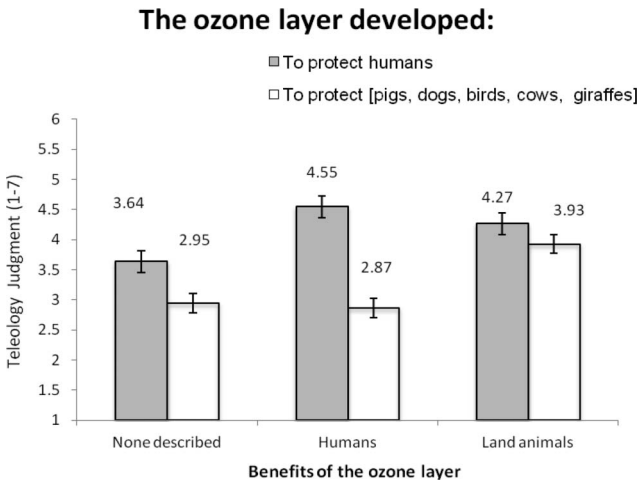

Figure 2. Anthro-teleological bias: Study 4.

Religion and teleological thinking. We also analyzed the role of religious belief in teleological thinking. Keeping with Study 1, religiousness was dummy coded (none = 0; religious = 1) based on religious affiliation data. Means for ozone teleology were analyzed by 3 (benefit) × 2 (religious: yes/no) × 2 (design: humans/nonhuman) with repeated measures on last variable. There was a main effect of religion on teleological thinking, $F(1, 475) = 43.51$, $p < .001$, $\eta_p^2 = .084$, 95% CI [0.05, 0.13], with religious people endorsing more teleological statements in general. Moreover, the Religion × Design interaction was significant, $F(1, 475) = 5.55$, $p = .019$, $\eta_p^2 = .012$, 95% CI [0.00, 0.03]. Both religious and nonreligious people inferred greater design toward humans, but the bias was larger among religious people.

Discussion

Study 4 found further support for an anthro-teleological bias and results parallel and extend those in Study 3. First, participants agreed more that the ozone layer developed to protect humans from UV radiation, compared with other species (e.g., cows, pigs). This effect was strongest in the human-benefit condition, where consequences for humans were stated explicitly, and in the control condition, where no benefits to any targets are stated. The effect observed in the control condition may be due to better awareness of the benefits for humans compared with other species. Indeed, the bias was reduced in the general-benefit condition, in which the ozone layer was described as protecting all land animals, a general category that is inclusive but not exclusive to humans. Unlike Study 3 that used only giraffes as a comparison, participants in Study 4 made teleological judgments for several different species, so no one species was singled out or contrasted with humans. Neither humans nor any of the other target species asked in the teleological items were mentioned in the description.

In both Studies 3 and 4, we used a phenomenon known to benefit humans: the ozone layer. Highlighting the general benefits to nonhumans reduced the effect, suggesting that greater knowledge or salience of consequences for humans does play a role in the anthro-teleological bias. Alternatively, it could be that anthropocentric biases intuitively elevate design when it applies to humans as soon as any benefit to humans becomes known. Important, highlighting benefits to nonhumans reduced the bias, but did not eliminate the bias, indicating that there may be a deep-rooted anthropocentrism at work that inflates inferences of design toward humans regardless of knowledge or salience of information. Study 5 examines this issue by testing whether the bias emerges spontaneously for phenomena when there is no prior knowledge of the benefits to humans or other species.

Study 5: Spontaneous Anthro-Teleological Bias

In four studies we observed a robust anthro-teleological bias in inferences to design. Studies 3 and 4 studied the anthro-teleological bias for a well-known phenomenon—the ozone layer—where people are already generally familiar with the benefits to humans and explored the role of observer effects and salience of benefits in reducing the bias. In a final study, we explore whether the anthro-teleological bias emerges spontaneously for phenomena where benefits to human and other life are not previously known. Such an effect would illustrate that anthropocentrism in teleological thinking is not a just a function of prior knowledge, but that deep-rooted anthropocentrism enhances intuitive perceptions of design that serve human life.

We selected "Jupiter as-shield" as the target phenomenon: that Jupiter's strong gravity attracts asteroids and comets toward it, and so protects the Earth (and other planets) from frequent collisions (Wetherill, 1994). Jupiter's gravity therefore has important implications for protecting life on Earth, including humans. But this phenomenon is not common knowledge—in pretesting, about 80% MTurk participants had no prior knowledge that Jupiter's gravity prevents asteroid collisions with Earth or other planets. Participants in the present study read information about Jupiter's strong gravity, in one of three between-subjects conditions. The control condition described Jupiter's gravity with no additional information on its positive implications. The Earth-benefit condition included information on how Jupiter's gravity protected the Earth from asteroids and comets by deflecting them toward Jupiter. Important, this has clear implications for life on Earth (including humans), but these consequences are only implied and not stated explicitly. In the planets-benefit condition, the consequences of Jupiter were generalized even further, here described as protecting all planets in the inner solar system (Mercury, Venus, Earth, and Mars). This was included to diffuse the benefits of the phenomena to a larger scale. As a test of anthro-teleological bias, participants in all conditions were asked whether Jupiter's gravity developed to protect humans, and five other species: cows, bears, giraffes, ducks, and tigers. Study 5, therefore, tests the depth of anthro-teleological biases by eliminating the prior knowledge about the natural phenomenon. We expect to find evidence for the anthro-teleological bias in both benefit conditions, with stronger inferences that Jupiter's gravity developed to protect humans, than to protect other species.

Method

Participants. We aimed to collect data from at least 120 participants for each target condition (less exclusions) to observe a medium-to-large effect size at 80% power. A requirement for this study is that participants learn about a novel natural phenomenon, and pretesting indicated that up to 20% of MTurk samples have previous knowledge of the Jupiter-as-shield phenomena, that we planned to omit from analyses. Five hundred two people were recruited on MTurk for a small fee. Of the respondents, 14.8% ($n = 73$) indicated that they knew about Jupiter-as-shield before the study and were omitted from analyses. Data from 10 participants were removed for duplicate IP addresses, leaving a remaining sample of 419 (M age = 37.7 years; 231 women, 170 men, one other, 17 not reporting).

Procedure. Participants in both studies were randomly assigned to condition in a 3 (benefit: none, Earth, planets) × 2 (likelihood) design. All participants began by reading a description of Jupiter's size and gravity. In the extremely unlikely conditions, the likelihood of Jupiter growing to its present large size was described as "one in 5 trillion." In the somewhat unlikely condition, this likelihood was described as "one in five (20% chance)."

In the no-benefit (control) condition, no benefits of Jupiter's gravitational pull were mentioned. In the Earth-benefit condition, the effects of Jupiter's gravity are described as protecting Earth, specifically from comets and asteroids. In the planet-benefit condition, the target beneficiaries described as "planets in the inner solar system." Before the target dependent measures, two multiple-choice questions asked participants to recall details about the size of Jupiter and the probability of it becoming so large. Five teleological items asked whether the Jupiter's gravity developed to protect humans, tigers, cows, bears, ducks, and giraffes, in random order, on respective seven-point scales endpoints 1 = *not at all*; 7 = *definitely*.

Finally, to measure prior knowledge about the phenomenon, participants were asked two items: (1) "Before this study, how familiar were you with the effects of Jupiter's size and gravity?" (seven-point scale, endpoints: 1 = *not at all familiar*; 7 = *very familiar*) and (2) "Before this study, did you know that Jupiter's gravity is responsible for keeping asteroids and comets away?" (yes, no, unsure).

Results

Anthro-teleological bias. Study 5 examined whether an anthro-teleological bias emerges spontaneously for phenomena that was previously unknown, where there is a general benefit for many targets. Teleology judgments for nonhumans (e.g., bears, ducks, tigers, giraffes, cows) showed high interitem reliability ($\alpha = .98$). Five-level repeated-measures ANOVA confirmed there were no differences in teleological judgments for these targets ($F < 1$). We therefore calculated the mean for these other-teleological judgments. Teleological judgment was analyzed by 3 (benefit: Earth, planets, control) × 2 (likelihood) × 2 (design: humans/other) mixed MANOVA with repeated measures on last variable. There was a robust main effect of design across all conditions reflecting an anthro-teleological bias: $F(1, 410) = 214.34$, $p < .001$, $\eta_p^2 = .34$, 95% CI [0.26, 0.39]. Overall, participants were more likely to endorse the design statement for humans ($M = 3.35$, $SD = 2.07$) than for other species ($M = 2.24$ $SD = 1.77$). There was no main effect of the likelihood condition ($F < 1$) or any interaction with likely and other conditions on teleology (Fs < 1). There was no main effect of benefit condition, $F(2, 410) = 1.70$, $p = .19$. The predicted Benefit × Design interaction was significant, $F(2, 410) = 4.82$, $p = .009$, $\eta_p^2 = .023$, 95% CI [0.01, 0.05] (see the means in Figure 3). The anthro-teleological bias was greater in the both the benefit-Earth and planet-benefit conditions, where Jupiter was described as protecting planets in the "inner solar system." Even if they are previously unaware of the natural benefits for humans, when general benefits are made apparent, people spontaneously show more teleological thinking toward humans than for other targets.

Religion and teleological thinking. As in previous studies, religion was dummy-coded (none = 0; religious = 1) based on

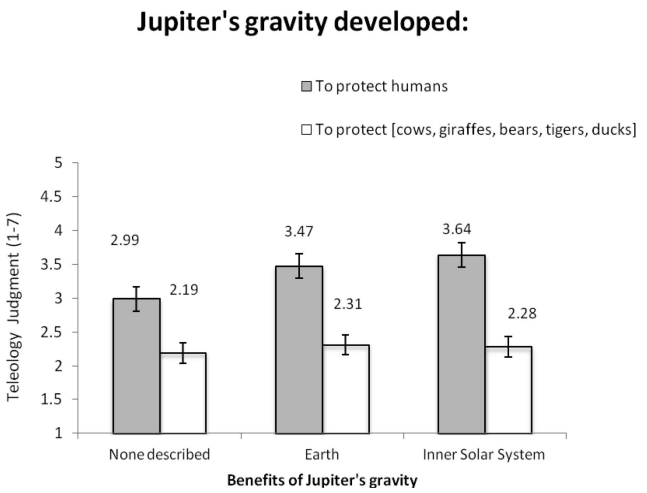

Figure 3. Anthro-teleological bias: Study 5.

religious affiliation data. There was a main effect of religion on teleological thinking, $F(1, 410) = 39.03$, $p < .001$, $\eta_p^2 = .087$, 95% CI [0.023, 0.13]. Religious people endorsed teleological statements more ($M = 2.73$, $SD = 1.79$) than nonreligious people ($M = 1.76$, $SD = 1.29$). There was a significant Religious × Design interaction, $F(1, 410) = 5.04$, $p = .025$, $\eta_p^2 = .012$. Religious and nonreligious people showed the anthro-teleological bias, but the bias was stronger in religious people.

Discussion

Study 5 examined a spontaneous anthro-teleological bias in response to a novel phenomenon, Jupiter-as-shield. Though participants were previously unaware how Jupiter's gravity prevented objects from regularly colliding with Earth (and other planets), they were more likely to say that Jupiter's gravity developed to protect humans that to protect other kinds of life on Earth. Notably, in the experimental conditions, Jupiter was described as shielding either Earth as a whole or the inner solar system as a whole, both of which are larger categories that include humans but are not exclusive to humans. Yet an anthro-teleological bias was observed in both these conditions, with stronger design perceived toward helping humans than other species (e.g., cows, giraffes, bears, tigers, ducks). Although no species are mentioned (humans or otherwise), the implications for humans were immediately applied to humans and seem to take priority over other targets. Interestingly, the effect was also observed in a control condition, that described the size of Jupiter and its gravity, but not how it deflects objects away from Earth or other planets. Yet when asked, naïve participants are still more likely to say it is to protect humans than any other species. This study illustrates the depth of anthropocentric bias in teleological reasoning. Anthro-teleological biases do not rely on privileged information about outcomes for humans but emerge spontaneously when benefits to humans are implied for new phenomena.

General Discussion

Our intuitive tendency for teleological thinking helps create the compelling impression that nature is designed to support life, especially when it concerns human life. In five studies. this research found evidence for an anthro-teleological bias to see more design toward humans. For example, it seems more intuitive that trees produce oxygen for humans, but less so that trees produce oxygen for leopards. Others have hinted at this bias in cosmological design inferences (Bostrom, 2013; Sagan, 1973), but this work is the first to show that people endorse design framed to help humans more than the same statements framed to help other targets.

Why More Design for Humans?

Teleological thinking toward nature is an explanatory stance grounded in social–cognitive biases to infer intentionality (Kelemen, 1999). But an important question to as is why these biases should be especially strong where it concerns our own species. Anthropocentric biases sharpen our attention to the ways that nature helps humans, and by doing so may accentuate design thinking toward humans through increased awareness and value of self-relevant outcomes.

Human-relevant outcomes are more salient. Anthropocentric biases are fundamentally an extension of egocentric biases, characterized by self-centered perspective on human experience. In general, egocentric biases give us privileged knowledge about things that affect the self, including private information about desires and intentions (Kruger & Gilovich, 2004; Pronin & Kugler, 2010). When we benefit from things which also benefit others, self-advantages are more apparent and exaggerated relative to others (Windschitl et al., 2003). For example, in a competitive trivia game, people overestimate the extent they are helped by clues relative to the same clues given to other players (Windschitl et al., 2003). Similarly, anthropocentric biases make us better at seeing how nature helps humans than how it helps others, which enhances relative teleological thinking toward humans.

We explored this in Studies 3 and 4 with a phenomenon well-known to benefit humans: the ozone layer. In Study 3, statements that the ozone layer developed "to protect humans" were supported more than statements about how it was developed to protect another specific target—giraffes. But this difference was reduced when the benefits to giraffes were made explicit beforehand. This could be the result of the overt comparison to a single target, perhaps signaling there is something special about giraffes as an example. But in Study 4, we made the general benefits of the ozone layer explicit for a category that included many targets—land animals—before teleological judgments toward various targets. Again, design statements directed toward humans were endorsed more strongly than for other targets. But increasing salience of the benefits to a category (land animals) reduced the difference in teleological judgments. Together, the results of Studies 3 and 4 demonstrate that the asymmetry in teleological judgments is partially due to skewed attention or awareness of the benefits for humans, as increasing salience of others' benefits reduces the effect. However, it is important to note it did not eliminate the bias entirely; there is still stronger design attributed toward humans when the advantages to others are made explicit. We also consistently observe anthro-teleological bias in the control conditions in all studies when no benefits to any target (human or otherwise) are described. Thus, greater knowledge about benefits to humans may contribute to greater perceived design to humans, but privileged

knowledge does not completely account for the tendency to infer more design toward humans than other targets.

Human-relevant outcomes are more special. A second reason that anthropocentrism can increase design toward humans is through inflated value given to human life. As humans, we see nature through an anthropocentric lens, and it is easy to tell ourselves a tale of why human life is special. We seem, to ourselves at least, to be the very pinnacle of life. Phenomena that benefit humans may lend itself to stronger teleology because these outcomes are valued more, and simply deemed more important. Anthropocentrism can therefore inflate the perception of design toward human life because these outcomes align with our own self-interests. This general idea is compatible with Kelemen's (1999) intention-based theory, in not only the attribution of beliefs and desires, but that action is inferred to match beliefs and desires (Dennett, 1987; Preston & Wegner, 2005). Specifically, cues that typically trigger teleological thinking may be especially sensitive where it concerns humans because it aligns with our own goals for survival. Liquin and Lombrozo (2018) have argued that an important factor in determining the appropriateness of a teleological explanation is its structure-function fit. For example, the idea that trees make oxygen so that animals can breathe is compelling not because it especially suits the biology of trees, but that it seems to serve a function—in this case to provide the life-supporting air we need to breathe. In comparison, people tend to reject "bad" teleological explanations (e.g., "animals grow ears because they need to smell things"; Kelemen & Rosset, 2009; Lombrozo & Carey, 2006) that do not follow a coherent causal logic. Processes that enable human survival directly align with our own goals, so it is easier—even sensible—to understand those functions through intentional processes.

This explanation was not directly tested here, but in Study 5, we examined whether the bias would emerge spontaneously for novel phenomena. Here, participants were exposed to new information about a natural phenomenon (Jupiter as shield) where the beneficial outcome was relevant to all life on Earth, including humans. In this case, the privileged knowledge of benefits to humans is not a factor, as participants had no prior knowledge at all. Humans were never named explicitly as a beneficiary; it is merely implied as it affects all life on Earth. Yet, people still attributed greater teleology for the event toward protecting humans than for other species—pigs, birds, and so forth Even with no prior information, and no specific information about humans, judgments of design toward humans still trumped those for other targets. The fact that human-directed teleology is endorsed spontaneously reflects it is perceived to be a good teleological explanation, that is, merits an intentional explanation, more so than for other targets. This spontaneous anthro-teleological bias for novel phenomena implies a deep anthropocentrism at work that automatically prioritizes implications for human life over other species.

Anthro-Teleological Bias or Belief

We also interested in the extent to which anthro-teleological thinking may be considered a cognitive bias, that is, a default to see greater design for humans, or a belief, that is, a conscious attitude that nature is intended to support humans. In Study 2, we examined whether the effects could be enhanced by a time pressure manipulation, following design of other studies. If design attributions toward humans increased under time pressure, this would be evidence for an intuitive default toward anthro-teleology that is controlled through conscious effort (Kelemen & Rosset, 2009). But the absence of such an effect does not suggest it is not a default (bias), but only that the preference is not deliberately controlled. Important, we also find the bias emerges spontaneously for novel phenomena that enable human survival—even though the circumstances reap benefits to many targets, and humans are not explicitly named as beneficiaries. This suggests that the tendency to attribute more design toward humans is automatic and intuitive. But importantly, this does not preclude the possibility that judgments are also affected by explicit beliefs that nature's purpose is to serve humans. Rather, anthro-teleological thinking may operate both intuitively and explicitly.

The interplay between explicit belief and intuitive biases on anthro-teleological thinking can be seen in the effects of religiousness on agreement with teleological statements. Teleological thinking is often stronger among religious people (Banerjee & Bloom, 2014), but not dependent upon religious belief (Järnefelt, Canfield, & Kelemen, 2015). We also found stronger teleological thinking among religious participants here, and in Studies 3 through 5, the anthro-teleological bias (that humans *are* preferentially seen as the target of design) was stronger in religious people as well. Most religious participants in these studies were Christian, a religion that often emphasizes the place of humans in creation—so it follows that these people may hold stronger explicit ideas that nature is designed and designed for humans specifically. But we also note the bias is not dependent on religious belief: nonreligious people also endorsed teleological items and perceived more design toward humans than other targets. Even without an explicit belief in a "designer" we see greater endorsement of design in nature toward humans. This suggests a deep-rooted intuition to perceive design toward humans, that is not derived from explicit religious belief. The preference for teleological thinking toward humans can operate as both bias and belief, with explicit and intuitive processes reinforcing each other. But it can also operate as a bias in contrast to explicit belief, emerging spontaneously when some serendipitous phenomenon enables our survival.

Anthropocentric, Geocentric, and Egocentric Designs

This research has explored whether there is a bias to see design in nature toward humans: an anthro-teleological bias. But interestingly, these biases also seem to extend to greater categories that include humans—at geocentric, biocentric, and even universe-centric levels. For some of our study items, it was Earth that was described as the beneficiary of the natural phenomenon, with the underlying implication that humans would be supported by outcomes on Earth, but not other planets. This illustrates that teleology can be skewed on a geocentric level—that is, the design is aimed toward the Earth as a whole. Other research has examined a kind of geo-teleological bias in concepts of a Gaia—that the Earth purposefully acts to preserve itself or if life-supporting abilities—for example, maintaining its temperature, producing oxygen, maintaining an ecosystem- but these tend to be framed as self-serving rather than other-serving (e.g., Järnefelt et al., 2015; Kelemen & Rosset, 2009). Intelligent design theories that emphasize the Earth as "just right" to support life may also reflect an

extension of anthropocentric biases to geocentric biases. Though it is the Earth that is the object of the design, it is life (and human life) that is the presumed reason for the design. Similarly, arguments that the universe itself is fine-tuned may reflect an extension of anthropocentrism toward the universe. Our universe is important because it is the one that contains us, and it appears fine-tuned because it is fine-tuned for intelligent life (i.e., humans).

Thus anthropocentric biases may underlie many biases in design. The Earth (and the Universe) do have ideal conditions to support life, but this only becomes fine-tuned as we consider implications for human life. But if specialness helps create the strong appearance of design, apparent ordinariness undermines that same design. Indeed, many of the most effective challenges to design arguments work by undermining the perceived specialness in one way or another. Recently, the search for Earth-like planets has uncovered many planets outside our solar system that could also be "just right" to support life (National Aeronautics and Space Administration, 2018), undermining the idea that Earth is a special habitat to support life. In relation to the anthropic principle, Smolin (1992) argued that multiverse models allow for a kind of natural selection to create more universes that can support life. Essentially, universes with the conditions to support life are also universes that have black holes, and these black holes in turn give birth to similar universes with similar conditions. Therefore life-supporting universes are more common than universes without life. In this model a universe like our own is hardly remarkable, but quite ordinary, perhaps inevitable. And the weak version of the anthropic principle points out the inherent observer bias: We would only be able to remark on the finetuned properties of the universe if we were already here to observe it. These arguments and counterarguments for intelligent design reflect how an outcome feels most designed when it seems remarkable, and without that intuition inferences to design seem wholly unnecessary. Indeed, it is this intuitive sense of specialness that underlies anthropocentric biases and drives teleological inferences.

But ultimately, geocentric and anthropocentric biases in design may all be an extension of egocentric biases in teleological thinking (Preston, 2018), which radiate at greater categories around the self. Indeed, we see some evidence for skewed teleological thinking at the individual level; for example, more meaning is given to coincidental events that affect oneself versus others (Falk, 1989), and individual egocentrism increases paranormal explanations for coincidence (Moore, Thalbourne, & Storm, 2010). One reason we may attribute more design toward humans as a species is that we overweight the value of our own personal outcomes as individuals. Events that impact humans (and oneself) capture our attention and feel inherently more important, Again, crucial here is that an anthropocentric (or egocentric) bias amplifies the perceived importance of the outcome—its apparent "specialness"—that can activate stronger inferences to design.

Conclusion

People are intuitive design thinkers and inherently anthropocentric. Together these biases conspire to make judgments of design especially likely when outcomes benefit humans—an anthro-teleological bias. This tendency can be adjusted if people see the same advantages for other species. But at the heart of the bias is that outcomes seem more special when they affect humans, which enhances our existing teleological thinking, and makes the anthro-teleological bias especially difficult to overcome.

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