

## Cultural influences on the teleological stance: evidence from China

Joshua Rottman<sup>a</sup>, Liqi Zhu<sup>b</sup>, Wen Wang<sup>c</sup>, Rebecca Seston Schillaci<sup>d</sup>, Kelly J. Clark<sup>e</sup> and Deborah Kelemen<sup>d</sup>

<sup>a</sup>Department of Psychology, Franklin & Marshall College, Lancaster, PA, USA; <sup>b</sup>Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences, Beijing, China; <sup>c</sup>Human Development and Family Studies, Michigan State University, East Lansing, MI, USA; <sup>d</sup>Department of Psychological and Brain Sciences, Boston University, Boston, MA, USA; <sup>e</sup>Kaufman Interfaith Institute, Grand Valley State University, Grand Rapids, MI, USA

### ABSTRACT

Recent research has suggested that humans have a robust tendency to default to teleological (i.e., purpose-based) explanations of natural phenomena. However, because samples have previously been heavily drawn from Western cultures, it is unclear whether this is a universal cognitive bias or whether prior findings are a product of Western philosophical and theological traditions. We evaluated these possibilities by administering a speeded judgment task to adults in China – a country that underwent nearly 40 years of institutionally enforced atheism in the Maoist era and which has markedly different cultural beliefs than those found in Western societies. Results indicated that even Chinese adults have a propensity to favor scientifically unwarranted teleological explanations under processing constraints. However, results also yielded suggestive evidence that Chinese culture may attenuate baseline tendencies to be teleological. Overall, this study provides the strongest evidence to date of the cross-cultural robustness of a teleological explanatory bias.

### KEYWORDS

Teleology; culture; cognitive universals; dual processing; China

AQ7



### 1. Introduction

Western philosophers and Christian theologians have long endorsed the idea that natural phenomena can be accounted for by reference to a putative function – believing, for example, that water exists *so that* life can survive on Earth. This “teleological” (i.e., purpose-based) framework is pervasive both in scholarly writings and in everyday discourse, often being prioritized over mechanistic explanations that refer to antecedent physical causes (e.g., Aristotle, c. 350 B.C./1930). Even despite modern advances in scientific understanding, most prominently the advent of evolutionary theory, scientifically unwarranted teleological explanations remain rampant in Western thought (see Kelemen, 2012). In this [article](#), we explore whether the ubiquity and frequent privileging of teleological explanation is primarily a legacy of the metaphysical claims embedded in much of Western culture or whether it additionally reflects something deeper about the natural structure of the human mind. Might a bias in favor of widespread purpose-based explanations be a universally developing aspect of human nature? If so, it should be detectable in a disparate cultural setting – for example in China, a society with radically different philosophical, religious, and historical traditions.

Results from a growing body of research support the hypothesis that a teleological bias is a reliably emerging and resilient feature of the human mind (e.g., Banerjee & Bloom, 2014; Barrett, 2012; Berling, 2011; Bloom, 2007; Kelemen, 1999a, 2004; Kelemen, Rottman, & Seston, 2013; Mills & Frowley,

2015). Young children (DiYanni & Kelemen, 2005; Kelemen, 1999b, 1999c, 2003; Kelemen & DiYanni, 2005; Sánchez Tapia et al., in press), Roma adults without formal schooling (Casler & Kelemen, 2008), and Alzheimer's patients with degraded conceptual knowledge (Lombrozo, Kelemen, & Zaitchik, 2007), all show broad biases to explain living and non-living natural phenomena in purpose-based terms. Furthermore, this tendency is not restricted to people who have limited knowledge of detailed mechanistic explanations of natural objects and events, but can also be revealed in highly educated adults. In one study, undergraduates and university professors living in the United States were asked to evaluate scientifically inaccurate teleological explanations, either under highly speeded conditions or with no time limits. Because speeded responding interrupts careful cognitive processing and inhibitory control, it is thought to expose default cognitive biases (e.g., Evans & Curtis-Holmes, 2005; also see Goldberg & Thompson-Schill, 2009; Shtulman & Valcarcel, 2012). Results of this study showed that college students, scientists (physicists, chemists, and geologists), and humanities professors all became markedly more prone to endorse unscientific teleological statements when responding under time pressure, an effect that was not matched in their responses to control items (Kelemen et al., 2013). American adults therefore appear to have a deep-seated tendency to construe natural phenomena as purpose driven, even when they have been extensively scientifically trained to endorse mechanistic, rather than teleological, explanations of nature. This finding is robust; despite one failure to replicate (Rottman, Greenway, Rose, Finke, & Kelemen, unpublished data), the effect has been demonstrated in multiple additional samples of American (Kelemen & Rosset, 2009) and Irish (Mills & Frowley, 2015) participants.

This overall body of evidence is consistent with the hypothesis that a teleological stance is a naturally emerging human universal. However, one issue is that these prior studies have been almost exclusively conducted in Westernized Judeo-Christian societies. Because intuitions are shaped by culturally transmitted information in addition to evolutionary processes, it is plausible that participants in these studies could possess internalized teleological biases from having been immersed in societies with extensive discourse invoking teleological explanations. For this reason, assertions about cognitive universals cannot be made confidently without cross-cultural data (Coley, 2000; Heine & Norenzayan, 2006). Existing evidence from the religiously polarized cultural context of Israel has found that, compared to orthodox Jewish children, secular Jewish children have markedly reduced tendencies to extend a teleological framework to animal and human categories (Diesendruck & Haber, 2009). This finding suggests that culture may indeed attenuate inclinations to default to teleological explanations. In the single non-Western context in which teleological intuitions have been examined (that of indigenous Quechua-speaking Peruvians), the participant population was chosen because it was hypothesized to foster *elevated* levels of scientifically unwarranted forms of teleological reasoning due to greater religiosity, less formal education, and an agricultural lifestyle – a prediction that was borne out by the data (Sánchez Tapia et al., in press; also see Gelman, Mannheim, Escalante, & Sánchez Tapia, in press). Therefore, further research is necessary to more broadly determine the cross-cultural robustness of the teleological bias and the extent to which cultural factors influence its manifestation. While a strong assertion of universality cannot be gleaned from the results of any single study and will require many years of comprehensive investigations in numerous cultural settings around the world, the present research represents a significant step in this direction by studying adult teleological thinking in a society that is highly distinct from the Western cultural groups in which a teleological bias has been previously documented.

There are several reasons to believe that patterns of culturally widespread information in Western countries such as the United States could robustly impact the expression of the teleological bias. Most prominently, cultural worldviews regarding the existence of an omnipotent creator god could enhance lifelong tendencies to attribute intentional causes to natural phenomena and, in turn, to treat natural kinds as artifact-like and endowed with a purpose. From infancy, the presence of order and design is tightly linked to inferences about intentional agency (Ma & Xu, 2013; Newman, Keil, Kuhlmeier, & Wynn, 2010), and young children often demonstrate a propensity to believe that supernatural beings are responsible for the origins of natural kinds (Evans, 2001; Gelman & Kremer,

1991; Petrovich, 1997). Even by early childhood, beliefs in a creator god are related to beliefs that natural entities are intentionally designed for a purpose (Diesendruck & Haber, 2009; Kelemen & DiYanni, 2005). It is therefore possible that the cultural endorsement of a powerful creator god is largely responsible for initiating a widespread bias to interpret all phenomena teleologically (Banerjee & Bloom, 2013; Geertz & Markusson, 2010; Gervais, Willard, Norenzayan, & Henrich, 2011; Harris & Koenig, 2006; Rottman & Kelemen, 2012).

In order to investigate whether cultural input substantially contributes to the teleological bias, it is crucial to conduct research in a society with minimal “God-talk” (Tickle, 1997). The present study investigated whether a default teleological stance is evident in Chinese adults, as China is officially an atheist nation and is arguably one of the least explicitly theistic societies in the world. A recent poll has found that 81.5% of Chinese people claim to lack religious belief, 75.2% deny the existence of supernatural agents, 83.9% believe that the afterlife does not exist, and 87.8% have never prayed to a supernatural power (Association of Religion Data Archives, 2007; also see WIN-Gallup International, 2012). These data contrast starkly with polls taken in the United States, for example, which have shown that the majority of Americans (61%) feel certain that God exists (Smith, 2012). Although the extent to which China is truly a non-theistic country is controversial, such that Chinese culture may foster religious tendencies to a greater extent than Western scholars have often supposed (Adler, 2005; Stark & Liu, 2011; Yang, 2004),<sup>1</sup> an anti-religious cultural narrative remains strong in Chinese schools and universities. Therefore, if a teleological bias is culturally constructed from religious discourse about divinely created natural phenomena, it should be dramatically reduced in educated Chinese individuals.

China is an ideal country in which to explore the universality of the teleological bias for other reasons as well. First, unlike other highly secular countries like Denmark and Sweden (Zuckerman, 2008), which share Greek and Abrahamic philosophical traditions with the other Western societies in which the teleological bias has previously been uncovered, China has an intellectual inheritance that is primarily rooted in Confucianism, Daoism, Mohism, Legalism, and Buddhism.<sup>2</sup> Second, in contrast to the categorical classification tendencies in the United States and other Western societies, Chinese adults tend to engage in relational classifications of organisms (Markus & Kitayama, 1991; Nisbett, 2003), for example grouping monkeys with functionally relevant foods (bananas) rather than with categorically similar animals (pandas) as is the case for American adults (Ji, Zhang, & Nisbett, 2004). This marked relational approach is relevant in light of recent theorizing about the conceptual origin of the teleological bias. Specifically, in contrast to views that characterize the teleological bias as either a basic cognitive tendency (Atran, 1995; Keil, 1992; Lombrozo & Carey, 2006) or one derived from more fundamental intentionality biases (Kelemen, 2004; Kelemen et al., 2013; also see Banerjee & Bloom, 2014; Willard & Norenzayan, 2013), a recent theoretical account of the teleological bias – the “relational-deictic” hypothesis – has posited that the widespread appeal of teleological explanations stems from the emphasis that teleological explanations place on the inherent interconnectedness of various entities in the world (ojalehto, Waxman, & Medin, 2013). For example, when explaining why earthworms tunnel underground, teleological explanations (e.g., “in order to aerate the soil”) inherently appeal to the interdependent relationships between earthworms and the dirt in which they live, whereas causal explanations (e.g., “because they move toward moisture and nourishment”) tend to be asocial and individualistic. China therefore presents an optimal place to explore the teleological bias because the strong cultural emphasis on connectedness and collectivism supports a prediction that relational Chinese adults should be more teleological than individualistic Americans.

In order to investigate the cross-cultural appeal of scientifically unwarranted teleological statements about natural phenomena, Chinese adults were presented with a speeded judgment task that has previously revealed a default tendency in Westerners to more strongly favor purpose-based explanations upon being placed under processing constraints (Kelemen & Rosset, 2009; Kelemen et al., 2013; Mills & Frowley, 2015). If a teleological bias is a universally intuitive explanatory stance (Keil, 1992; Kelemen, 2003, 2004; Lombrozo & Carey, 2006; Lombrozo et al., 2007), then

an increase in the endorsement of teleological explanations under speeded conditions should be observed in China, despite the geographical and historical gaps that separate it from Western countries and the disparate worldview of its inhabitants. However, if a teleological bias is contingent upon the cultural endorsement of a creator god, then atheistic tendencies in China should lead to muted endorsements of teleological ideas under both explicit unspeeded conditions and implicit speeded conditions. Conversely, if a teleological bias is derived from relational reasoning, then cultural differences in emphases on relatedness predict that Chinese adults should manifest heightened tendencies to endorse teleological explanations even under unspeeded conditions.

## 2. Methods

### 2.1. Participants

Chinese students ( $N = 105$ , 52 female,  $M_{\text{age}} = 22.5$ ,  $SD = 1.7$ ) from Beijing Forestry University and Beihang University participated in the study at the Chinese Academy of Sciences in Beijing. Participants were randomly assigned to a speeded or unspeeded condition.<sup>3</sup>

### 2.2. Materials and procedure

The procedure was identical to that of Kelemen et al. (2013). However, all measures were presented in Mandarin. In the speeded judgment task, participants were presented with 100 sentences (30 test and 70 control sentences) that explained “why things happen.” These explanations were presented consecutively on a laptop with PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants were instructed to judge each sentence as being “true” or “false” by pressing one of two labeled response keys on the keyboard. Test sentences presented false (i.e., scientifically inaccurate) teleological explanations for natural phenomena (e.g., “Trees produce oxygen so that animals can breathe”). Control sentences consisted of 20 true causal explanations of natural phenomena, 30 false causal explanations of natural phenomena, 10 true teleological explanations of human intentions or artifact functions, and 10 false teleological explanations of human intentions or artifact functions (see Table 1 for examples; for a full list, including translations, see Table S1 in the [online supplementary materials](#)). Control sentences were matched to test sentences for reading time in Mandarin, and they therefore provided a measurement of participants’ abilities to accurately judge explanations under speeded conditions.

Sentences were presented in 10 ten-sentence blocks that each contained a randomized assortment of three test items and seven control items, with a three-second pause after each block. Two

**Table 1.** Examples of test and control items.

Sentence Type	Item (correct answer in parentheses)
Test	Birds transfer seeds in order to help plants germinate. (false) 鸟类传播种子是为了帮助植物发芽。
	Germes mutate in order to become drug resistant. (false) 病菌变异是为了变得具有抗药性。
	Moss forms around rocks in order to stop soil erosion. (false) 苔藓长在岩石周围是为了防止土壤侵蚀。
	The Earth has an ozone layer in order to protect it from UV light. (false) 地球有一层臭氧是为了保护地球不受紫外线伤害。
	Women put on perfume in order to smell pleasant. (true) 女人喷香水是为了闻起来很香。
Control	People chew food in order to strengthen their jaw muscles. (false) 人们咀嚼食物是为了增强他们的咀嚼肌。
	Soda fizzes because carbon dioxide gas is released. (true) 汽水起泡是因为二氧化碳气体被释放。
	Oceans have waves because they contain a lot of saltwater. (false) 海洋中有波浪因为其含有大量的咸水。

205 unanalyzed blocks of practice sentences were additionally included at the beginning of the task to allow speeded participants to become accustomed to the allotted response time. Participants in the speeded condition were allowed a maximum of 5.3 seconds to respond (two standard deviations above the average reading time for Chinese pilot participants, which was determined to provide just enough time to comprehend each sentence and provide a response). If participants did not press a key within this time, the stimulus progressed automatically. In the unspeeded condition, participants were allowed an unlimited amount of time to respond.

210 Several additional measures were included to explore individual differences in responses on the speeded judgment task. First, because a tacit teleological bias may be effortfully suppressed by scientifically valid modes of reasoning (Kelemen & Rosset, 2009), we presented participants with the classic Stroop color task (Stroop, 1935) with Mandarin color words in order to measure individual differences in the ability to inhibit prepotent responses (for sample items, see Table S2 in the [online supplementary materials](#)). Next, participants completed translated versions of the Conceptual Inventory of Natural Selection (Anderson, Fisher, & Norman, 2002) and the Geoscience Concept Inventory (Libarkin & Anderson, 2006) in order to assess whether stronger scientific content knowledge weakens the teleological bias. Additionally, because a primary rationale for testing Chinese participants was their ostensibly lower level of religiosity, we measured beliefs in supernatural agents, asking participants to rate their agreement with the statement: “I believe in the existence of god(s)” (“我相信神的存在”). The general and encompassing word “神” (“shen”) was used because many Eastern religions are polytheistic and because this phrasing allows for endorsement by both polytheists and monotheists. Finally, participants rated their agreement to two statements assessing agent-based “Gaia” beliefs in Mother Nature.<sup>4</sup>

225 All stimuli underwent several rounds of translation, back-translation, and discussion by bilingual translators in the United States and China who were blind to the hypotheses of the study. After data collection, a discussion with an additional expert caused us to become concerned about the potential for ambiguous translations of some items (e.g., for the “Gaia” item measuring belief in “Nature as a powerful being”). We therefore convened a further panel of bilingual, bicultural translators who were also blind to the hypotheses of the study. On the basis of their extensive discussions, several items were excluded from analyses for having ambiguous translations. Excluded items were three (out of 30) experimental items and eight (out of 70) control items from the speeded judgment task, six (out of 20) questions from the Conceptual Inventory of Natural Selection, four (out of 22) questions from the Geoscience Concept Inventory, and both of the questions measuring Gaia beliefs. Exclusion of three test items from the speeded judgment task and four items from the Geoscience Concept Inventory was already planned based on the opinions of scientific experts (see Kelemen et al., 2013 for discussion). Final analyses therefore involved 24 test sentences from the speeded judgment task and 18 items from the Geoscience Concept Inventory. Importantly, however, the inclusion of all items across all tasks does not change the overall pattern of results.

### 240 3. Results

245 Responses were coded as 0 (accurate) or 1 (inaccurate). To determine the effect of time pressure on participants’ endorsements of scientifically inaccurate teleological statements about nature, as compared to their inaccuracy on control items, a 2 (Condition: speeded vs. unspeeded) X 2 (Sentence Type: test vs. control) repeated-measures ANOVA was conducted on participants’ responses. This analysis revealed a main effect of Condition,  $F(1, 103) = 16.80, p < .001, \eta_p^2 = .14$ , indicating a higher proportion of errors in the speeded condition. There was also a main effect of Sentence Type,  $F(1, 103) = 202.26, p < .001, \eta_p^2 = .66$ , indicating that participants were much more inaccurate on test items overall. Crucially, there was a Condition X Sentence Type interaction,  $F(1, 103) = 4.30, p = .041, \eta_p^2 = .04$ , demonstrating that the effect of speeded responding was more pronounced for test items than for control items. In particular, the speeded condition led to a 14% increase in the inaccurate endorsement of teleological statements, while there was only a 6% increase in the

255

260

265

270

275

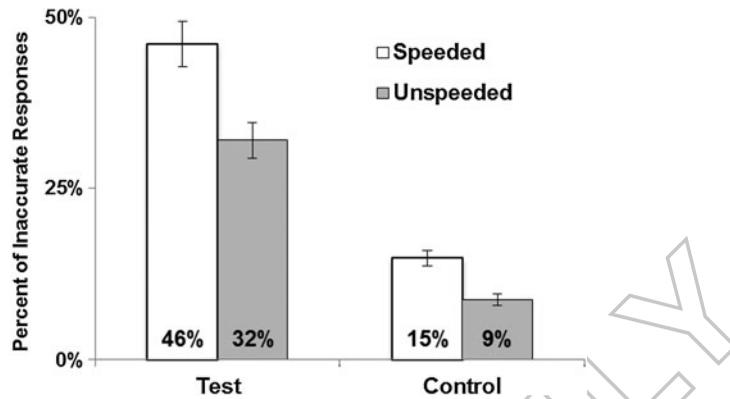
280

285

290

295

300



**Figure 1.** Percentages of inaccurate responses on teleological test items and on control items. Error bars are standard errors of the mean.

AQ9



inaccurate endorsement of control statements (see Figure 1). This replicates previous findings (Kelemen & Rosset, 2009; Kelemen et al., 2013) and demonstrates that mere processing speed is not the primary factor in the elevation of teleological endorsement. Rather, the interaction effect suggests that responding under speed interferes with inhibitory processes that must be engaged when denying teleological explanations, but which are unnecessary for evaluating control sentences. In other words, this research suggests that Chinese participants possess an intuitive bias to endorse teleological explanations that are otherwise effortfully suppressed. Because this sample was drawn from a cultural setting that is highly distinct from the Westernized populations that have been studied in previous research, this result lends support to the hypothesis that the teleological bias may be a universal cognitive default.

The relationships between teleological endorsement and knowledge/belief variables were examined with partial correlations, controlling for inaccuracy on control item responding in the speeded judgment task. Overall, scientific knowledge demonstrated a robust negative correlation with inaccurate teleological endorsement, Biological Knowledge:  $r(101) = -.35, p < .001$ ; Geoscience Knowledge:  $r(101) = -.30, p = .002$ . There was no relationship detected between performance on the Stroop task and inaccuracy on test items,  $r(101) = .06, p = .574$ . Belief in gods was additionally uncorrelated with inaccurate teleological endorsement,  $r(101) = .08, p = .415$ . However, consistent with the low levels of religious beliefs found by the Association of Religion Data Archives (2007), Chinese participants reported very low levels of belief in gods, with a mean rating of 1.81 ( $SD = 1.00$ ) on a 1 (strongly disagree) to 5 (strongly agree) scale – a rating that is well below the midpoint of this scale,  $t(103) = -12.21, p < .001$ .

#### 4. Discussion

This research has uncovered empirical evidence demonstrating that a teleological bias is present in China, a non-Western, non-Judeo-Christian society. In particular, Chinese adults revealed a pronounced tendency to endorse scientifically unwarranted teleological statements about the natural world when their processing resources were taxed through a demanding time constraint that precluded them from inhibiting default intuitions. The present demonstration that the teleological bias is robust in a cultural milieu highly distinct from those in which it has been previously documented provides the strongest indication to date that this explanatory form is a universally emerging stance, one that may develop regardless of environmental variation.

In prior research measuring endorsement of the same set or a subset of the teleological test items utilized in the present study (Banerjee & Bloom, 2014; Davis, Juhl, & Routledge, 2011; Kelemen &

Rosset, 2009; Kelemen et al., 2013; Mills & Frowley, 2015; Willard & Norenzayan, 2013), Western participants who were otherwise demographically similar to the present sample (e.g., university students) were found to endorse scientifically unwarranted teleological statements more than 50% of the time on average. This is substantially higher than the degree of endorsement found in the present sample of Chinese participants,<sup>5</sup> suggesting that overall teleological tendencies are diminished in Chinese culture. Therefore, even though Chinese adults possess a resilient tendency to endorse unwarranted teleological explanations when they are cognitively taxed, they simultaneously display a reduction in the overall extent to which they endorse teleological statements relative to similar counterparts in the United States, Canada, and Ireland. It is possible that this cross-cultural difference in mean levels of teleological endorsement reflects surface-level dissimilarities in reflective beliefs (Bering, 2010), such that explicit worldviews in China reduce the overall tendency to endorse scientifically unwarranted teleological explanations. That is, factors such as secularism could lead to the effortful chronic suppression of a universally held teleological bias (Barrett, 2012; Bering, 2011; Heywood & Bering, 2013; Järnefelt, Canfield, & Kelemen, 2015), while implicit biases continue to form in spite of these reflective cultural beliefs.

Beyond shedding light on the potential universality of an adult teleological bias, these results also yield some insight into the underlying structure of the teleological bias. Prominently, the findings fail to lend support to recent claims that teleological tendencies are actually a reflection of a more general tendency to think in relational-deictic terms (ojalehto et al., 2013). Despite robust evidence that Chinese culture emphasizes and enhances relational reasoning more than American culture (Ji et al., 2004; Nisbett, 2003), Chinese students were less teleological than adults previously tested in Western samples. Additionally, while decreased religiosity could be partially responsible for attenuating the teleological bias at an intercultural level, the lack of a relationship between belief in gods and teleological endorsement in the present sample suggests that religiosity may not impact this bias at an intracultural level. Overall, the relationship between formal religion and teleology is not straightforward (see Banerjee & Bloom, 2014; Lombrozo et al., 2007; Willard & Norenzayan, 2013), and further research should employ subtler, more implicit measures of religiosity (e.g., Järnefelt et al., 2015). It is possible that implicit measures would be more closely related to the teleological bias in China, especially as magical beliefs and ritualistic activities (e.g., ancestor veneration, fortune telling, incense burning) suggesting latent commitments to supernatural phenomena are much more prevalent in this country than overt faith in the existence of doctrinally prescribed supernatural beings (Yang & Hu, 2012).

Overall, these data provide new support to the hypothesis that a teleological stance is a universally intuitive cognitive propensity, even if its overall expression can be cross-culturally variable. The teleological bias persists into adulthood despite ameliorating influences, enduringly co-existing alongside other explanatory theories rather than being replaced through processes of conceptual change (Kelemen & Rosset, 2009; Legare, Evans, Rosengren, & Harris, 2012). It is possible that this canalized tendency results from innately endowed predispositions, perhaps nascent from birth, which bias humans to believe that teleological forces underlie natural phenomena (e.g., Barrett, 2012; Bering, 2011; Bloom, 2007; Järnefelt et al., 2015; Kelemen, 1999a, 2004). Alternatively, this predilection may be directly taught through common folklore or may be reliably constructed from similar environmental inputs that recur across cultures, becoming more or less pronounced depending on the availability of other explanatory frameworks such as modern biological theories. While future studies are required to uncover the precise mechanisms of genetic and cultural influence on the emergence and expression of this affinity for teleological explanation, the present research contributes to a growing body of studies demonstrating that the entrenchment of this tendency runs deep.

## Notes

1. While Chinese religions such as Buddhism and Daoism are allegedly non-theistic, China has had and continues to have a substantial number of theistic believers (Lagerway & Kalinowski, 2011). Though religious beliefs and

practices were dramatically affected under communism, recent decades have seen a marked increase in religious practice, much of it – even among Buddhists and Daoists – theistic (Yang, 2011). Furthermore, recent analyses of ancient texts suggest that both anthropomorphic theism and mind-body dualism have ancient roots in the literary culture (e.g., Clark & Winslett, 2011; Slingerland & Chudek, 2011).

2. This is not an exhaustive list; for example, the recent influences of post-Enlightenment thought (e.g., positivism, Marxism) have also been considerable.
3. The data were also reanalyzed after omitting 11 participants due to low (60%–80%) accuracy on control items, based on exclusion criteria from prior research that were designed to eliminate individuals who were unable to accurately read and respond to the stimuli under speeded conditions (see Kelemen et al., 2013). The pattern of results remained the same.
4. These questions were embedded within another 11 questions about scientific beliefs that were not analyzed and will not be discussed further.
5. For instance, a comparison to the undergraduate sample in Kelemen et al. (2013) demonstrates that the present Chinese sample is markedly less teleological,  $t(333) = 5.72, p < .001, d = 0.67$ .

## Acknowledgments

We thank Justin Barrett, Marian Chen, Laure Saint Georges, Ted Slingerland, and Rob Weller, as well as Rich Sosis and an anonymous reviewer, for their invaluable advice and assistance. We also thank Natalie Emmons, Elisa Järnefelt, and Adena Schachner for helpful feedback on a draft of this manuscript. We are especially grateful to our translators: Fang Hong, Jonathan Leu, Chen Shen, Kelly Wei, Wan Wei, Justin Winslet, Sophie Wu, and Liang Xu.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This research was supported by NSF GRF [grant number DGE-1247312] to J.R., John Templeton World Charities Foundation sub-award [grant number TWCF0020-WP1] to D.K., and Chinese Academy of Sciences project [grant number KJZD-EW-L04] to L.Z.

## Supplemental data

Supplemental data for this article can be accessed [10.1080/2153599X.2015.1118402](https://doi.org/10.1080/2153599X.2015.1118402).

## References

- Adler, J.A. (2005). Chinese religion: An overview. In L. Jones (Ed.), *Encyclopedia of religion* (2nd ed., pp. 1580–1613). Detroit, MI: Macmillan Reference.
- Anderson, D.L., Fisher, K.M., & Norman, G.J. (2002). Development and evaluation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching*, 39, 952–978. doi: 10.1002/tea.10053
- Aristotle. (1930). *Physica*. In W.D. Ross (Ed.). Oxford: Clarendon Press. (Original work published c. 350 BC).
- Association of Religion Data Archives. (2007). *Spiritual life study of Chinese residents*. Retrieved from [http://www.thearda.com/Archive/Files/Codebooks/SPRTCHNA\\_CB.asp](http://www.thearda.com/Archive/Files/Codebooks/SPRTCHNA_CB.asp)
- Atran, S. (1995). Causal constraints on categories and categorical constraints on biological reasoning across cultures. In D. Sperber, D. Premack, & A.J. Premack (Eds.), *Causal cognition: A multidisciplinary debate* (pp. 205–233). New York: Oxford University Press.
- Banerjee, K., & Bloom, P. (2013). Would Tarzan believe in God? Conditions for the emergence of religious belief. *Trends in Cognitive Sciences*, 17(1), 7–8. doi: 10.1016/j.tics.2012.11.005
- Banerjee, K., & Bloom, P. (2014). Why did this happen to me? Religious believers' and non-believers' teleological reasoning about life events. *Cognition*, 133(1), 277–303. doi: 10.1016/j.cognition.2014.06.017
- Barrett, J.L. (2012). *Born believers: The science of children's religious belief*. New York: Free Press.
- Bering, J. (2011). *The belief instinct: The psychology of souls, destiny, and the meaning of life*. New York: Norton.
- Bering, J.M. (2010). Atheism is only skin deep: Geertz and Markusson rely mistakenly on sociodemographic data as meaningful indicators of underlying cognition. *Religion*, 40(3), 166–168. doi: 10.1016/j.religion.2009.11.001
- Bloom, P. (2007). Religion is natural. *Developmental Science*, 10(1), 147–151. doi: 10.1111/j.1467-7687.2007.00577.x

AQ8

▲

AQ1

▲

AQ2

▲

- Casler, K., & Kelemen, D. (2008). Developmental continuity in teleo-functional explanation: Reasoning about nature among Romanian Romani adults. *Journal of Cognition and Development*, 9(3), 340–362. doi: 10.1080/15248370802248556
- Clark, K.J., & Winslett, J.T. (2011). The evolutionary psychology of Chinese religion: Pre-Qin High Gods as punishers and rewarders. *Journal of the American Academy of Religion*, 79(4), 928–960. doi: 10.1093/jaarel/lfr018
- 405 Cohen, J.D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: An interactive graphic system for designing and controlling experiments in the psychology laboratory using Macintosh computers. *Behavioral Research Methods, Instruments, and Computers*, 25, 257–271.
- Coley, J.D. (2000). On the importance of comparative research: The case of folkbiology. *Child Development*, 71(1), 82–90.
- 410 Davis, W.E., Juhl, J., & Routledge, C. (2011). Death and design: The terror management function of teleological beliefs. *Motivation and Emotion*, 35(1), 98–104. doi: 10.1007/s11031-010-9193-6
- Dawkins, R. (2006). *The God delusion*. New York: Houghton Mifflin.
- Diesendruck, G., & Haber, L. (2009). God's categories: The effect of religiosity on children's teleological and essentialist beliefs about categories. *Cognition*, 110(1), 100–114. doi: 10.1016/j.cognition.2008.11.001
- DiYanni, C., & Kelemen, D. (2005). Time to get a new mountain? The role of function in children's conceptions of natural kinds. *Cognition*, 97(3), 327–335. doi: 10.1016/j.cognition.2004.10.002
- 415 Evans, E.M. (2001). Cognitive and contextual factors in the emergence of diverse belief systems: Creation versus evolution. *Cognitive Psychology*, 42(3), 217–266. doi: 10.1006/cogp.2001.0749
- Evans, J.St.B.T., & Curtis-Holmes, J. (2005). Rapid responding increases belief bias: Evidence for the dual-process theory of reasoning. *Thinking & Reasoning*, 11(4), 382–389. doi: 10.1080/13546780542000005
- Geertz, A.W., & Markússon, G.I. (2010). Religion is natural, atheism is not: On why everybody is both right and wrong. *Religion*, 40(3), 152–165. doi: 10.1016/j.religion.20
- 420 Gelman, S.A., & Kremer, K.E. (1991). Understanding natural cause: Children's explanations of how objects and their properties originate. *Child Development*, 62(2), 396–414.
- Gelman, S.A., Mannheim, B., Escalante, C., & Sánchez Tapia, I. (in press). Teleological talk in parent-child conversations in Quechua. *First Language*.
- Gervais, W.M., Willard, A.K., Norenzayan, A., & Henrich, J. (2011). The cultural transmission of faith: Why innate intuitions are necessary, but insufficient, to explain religious beliefs. *Religion*, 41(3), 389–410. doi: 10.1080/0048721X.2011.604510
- 425 Goldberg, R.F., & Thompson-Schill, S.L. (2009). Developmental "roots" in mature biological knowledge. *Psychological Science*, 20(4), 480–487. doi: 10.1111/j.1467-9280.2009.02320.x
- Harris, P., & Koenig, M. (2006). Trust in testimony: How children learn about science and religion. *Child Development*, 77(3), 505–524. doi: 10.1111/j.1467-8624.2006.00886.x
- 430 Heine, S.J., & Norenzayan, A. (2006). Toward a psychological science for a cultural species. *Perspectives on Psychological Science*, 1(3), 251–269. doi: 10.1111/j.1745-6916.2006.00015.x
- Heywood, B.T., & Bering, J.M. (2013). "Meant to be": How religious beliefs and cultural religiosity affect the implicit bias to think teleologically. *Religion, Brain & Behavior*, 1–19. doi: 10.1080/2153599X.2013.782888
- Järnefelt, E., Canfield, C.F., & Kelemen, D. (2015). The divided mind of a disbeliever: Intuitive beliefs about nature as purposefully created among different groups of non-religious adults. *Cognition*, 140, 72–88. doi: 10.1016/j.cognition.2015.02.005
- 435 Ji, L.-J., Zhang, Z., & Nisbett, R.E. (2004). Is it culture or is it language? Examination of language effects in cross-cultural research on categorization. *Journal of Personality and Social Psychology*, 87(1), 57–65. doi: 10.1037/0022-3514.87.1.57
- Keil, F.C. (1992). The origins of an autonomous biology. In M. Gunnar & M. Maratsos (Eds.), *Modularity and constraints in language and cognition: The Minnesota symposia* (pp. 103–137). Hillsdale, NJ: Erlbaum.
- 440 Kelemen, D. (1999a). Beliefs about purpose: On the origins of teleological thought. In M. Corballis & S. Lea (Eds.), *The descent of mind*. Oxford: Oxford University Press.
- Kelemen, D. (1999b). The scope of teleological thinking in preschool children. *Cognition*, 70, 241–272.
- Kelemen, D. (1999c). Why are rocks pointy? Children's preference for teleological explanations of the natural world. *Developmental Psychology*, 35(6), 1440–1452.
- Kelemen, D. (2003). British and American children's preferences for teleo-functional explanations of the natural world. *Cognition*, 88(2), 201–221. doi: 10.1016/S0010-0277(03)00024-6
- 445 Kelemen, D. (2004). Are children "intuitive theists?" Reasoning about purpose and design in nature. *Psychological Science*, 15(5), 295–301. doi: 10.1111/j.0956-7976.2004.00672.x
- Kelemen, D. (2012). Teleological minds: How natural intuitions about agency and purpose influence learning about evolution. In K.S. Rosengren, S.K. Brem, E.M. Evans, & G.M. Sinatra (Eds.), *Evolution challenges: Integrating research and practice in teaching and learning about evolution* (pp. 66–92). Oxford, England: Oxford University Press.
- 450 Kelemen, D., & DiYanni, C. (2005). Intuitions about origins: Purpose and intelligent design in children's reasoning about nature. *Journal of Cognition and Development*, 6(1), 3–31. doi: 10.1207/s15327647jcd0601\_2

AQ3



AQ4



AQ5



- Kelemen, D., & Rosset, E. (2009). The human function compunction: Teleological explanation in adults. *Cognition*, 111(1), 138–143. doi: 10.1016/j.cognition.2009.01.001
- Kelemen, D., Rottman, J., & Seston, R. (2013). Professional physical scientists display tenacious teleological tendencies: Purpose-based reasoning as a cognitive default. *Journal of Experimental Psychology: General*, 142(4), 1074–1083. doi: 10.1037/a0030399
- 455 Lagerway, J., & Kalinowski, M. (Eds.). (2011). *Early Chinese religion, part one: Shang through Han (1250 BC-220 AD)*. Leiden, Holland: Brill.
- Legare, C.H., Evans, E.M., Rosengren, K.S., & Harris, P.L. (2012). The coexistence of natural and supernatural explanations across cultures and development. *Child Development*, 83(3), 779–793. doi: 10.1111/j.1467-8624.2012.01743.x
- 460 Libarkin, J.C., & Anderson, S.W. (2006). The Geoscience Concept Inventory. In X. Liu & W.J. Boone (Eds.), *Applications of Rasch measurement in science education* (pp. 45–73). Fort Dodge, IA: JAM Publishers.
- Lombrozo, T., & Carey, S. (2006). Functional explanation and the function of explanation. *Cognition*, 99(2), 167–204. doi: 10.1016/j.cognition.2004.12.009
- Lombrozo, T., Kelemen, D., & Zaitchik, D. (2007). Inferring design: Evidence of a preference for teleological explanations in patients with Alzheimer's disease. *Psychological Science*, 18(11), 999–1006. doi: 10.1111/j.1467-9280.2007.02015.x
- 465 Ma, L., & Xu, F. (2013). Preverbal infants infer intentional agents from the perception of regularity. *Developmental Psychology*, 49(7), 1330–1337. doi: 10.1037/a0029620
- Markus, H.R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98(2), 224–253. doi: 10.1037/0033-295X.98.2.224
- Mills, R., & Frowley, J. (2015). Promiscuous teleology and the effect of locus of control. *The Irish Journal of Psychology*, 35, 121–132. doi: 10.1080/03033910.2015.1011192
- 470 Newman, G.E., Keil, F.C., Kuhlmeier, V.A., & Wynn, K. (2010). Early understandings of the link between agents and order. *Proceedings of the National Academy of Sciences*, 107(40), 17140–17145. doi: 10.1073/pnas.0914056107
- Nisbett, R.E. (2003). *The geography of thought: How Asians and Westerners think differently ... and why*. New York: Free Press.
- ojalehto, B., Waxman, S.R., & Medin, D.L. (2013). Teleological reasoning about nature: Intentional design or relational perspectives? *Trends in Cognitive Sciences*, 17(4), 166–171. doi: 10.1016/j.tics.2013.02.006
- 475 Petrovich, O. (1997). Understanding of non-natural causality in children and adults: A case against artificialism. *Psyche en Geloof*, 8, 151–165.
- Rottman, J., & Kelemen, D. (2012). Is there such a thing as a Christian child? Evidence of religious beliefs in early childhood. In P. McNamara & W.J. Wildman (Eds.), *Science and the world's religions* (Vol. 2, pp. 205–238). Santa Barbara, CA: Praeger.
- Sánchez Tapia, I., Gelman, S.A., Hollander, M.A., Manczak, E.M., Mannheim, B., & Escalante, C. (in press). Development of teleological explanations in Peruvian Quechua-speaking and U.S. English-speaking preschoolers and adults. *Child Development*.
- 480 Shtulman, A., & Valcarcel, J. (2012). Scientific knowledge suppresses but does not supplant earlier intuitions. *Cognition*, 124(2), 209–215. doi: 10.1016/j.cognition.2012.04.005
- Slingerland, E., & Chudek, M. (2011). The prevalence of mind-body dualism in Early China. *Cognitive Science*, 35(5), 997–1007. doi: 10.1111/j.1551-6709.2011.01186.x
- 485 Smith, T.W. (2012). *Beliefs about God across time and countries*. Retrieved from <http://publicdata.norc.org:41000/gss/documents//CNRT/Godissp.pdf>
- Stark, R., & Liu, E.Y. (2011). The religious awakening in China. *Review of Religious Research*, 52(3), 282–289.
- Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643–662. doi: 10.1037/h0054651
- Tickle, P.A. (1997). *God-talk in America*. New York: Crossroads.
- 490 Willard, A.K., & Norenzayan, A. (2013). Cognitive biases explain religious belief, paranormal belief, and belief in life's purpose. *Cognition*, 129(2), 379–391. doi: 10.1016/j.cognition.2013.07.016
- WIN-Gallup International. (2012). *Global index of religiosity and atheism*. Retrieved from <http://www.wingia.com/web/files/news/14/file/14.pdf>
- Yang, F. (2004). Between secularist ideology and desecularizing reality: The birth and growth of religious research in communist China. *Sociology of Religion*, 65(2), 101–119.
- 495 Yang, F. (2011). *Religion in China: Survival and revival under communist rule*. New York: Oxford University Press.
- Yang, F., & Hu, A. (2012). Mapping Chinese folk religion in Mainland China and Taiwan. *Journal for the Scientific Study of Religion*, 51(3), 505–521.
- Zuckerman, P. (2008). *Society without God: What the least religious nations can tell us about contentment*. New York: New York University Press.