General Article

Are Children "Intuitive Theists"?

Reasoning About Purpose and Design in Nature

Deborah Kelemen

Boston University

ABSTRACT—*Separate bodies of research suggest that young children have a broad tendency to reason about natural phenomena in terms of purpose and an orientation toward intention-based accounts of the origins of natural entities. This article explores these results further by drawing together recent findings from various areas of cognitive developmental research to address the following question: Rather than being "artificialists" in Piagetian terms, are children "intuitive theists"—disposed to view natural phenomena as resulting from nonhuman design? A review of research on children's concepts of agency, imaginary companions, and understanding of artifacts suggests that by the time children are around 5 years of age, this description of them may have explanatory value and practical relevance.*

Piaget's (1929) claim that children are "artificialists" who draw on their subjective intentional experience to conclude that all things are made by people for a purpose has encountered substantial skepticism in the past few decades of cognitive developmental research. This is because, at core, Piaget's proposal embodied not just the suggestion that children misunderstand the limits of human creative power, but a stronger claim about the profound incommensurability of children's and adults' conceptual systems. Specifically, Piaget believed that young children indiscriminately generate artificialist explanations because they are psychologically incapable of conceiving of physical causes, a shortcoming that he argued rendered them insensitive to the fundamental distinction between natural kinds and artifacts.

Research since Piaget has challenged these assumptions. Not only can children reason in physical-causal terms from infancy (e.g., Baillargeon, 1993), but they also recognize that people make artifacts, not natural entities (e.g., Gelman & Kremer, 1991). But although these results may put some aspects of Piaget's interpretation to rest, recent research has raised the specter of Piaget's findings once more. Consistent with Piaget's results, contemporary studies have found that, although children are not entirely indiscriminate, they do indeed evidence a general bias to treat objects and behaviors as existing for a purpose (Kelemen, 1999b, 1999c, 2003; but see Keil, 1992) and are also broadly inclined to view natural phenomena as intentionally created, albeit by a nonhuman agent (Evans, 2000b, 2001; Gelman & Kremer, 1991). This article explores these findings further by drawing them together with other recent cognitive developmental research to address the following question: Even if children are not artificialists, as Piaget conceived of the term, are they perhaps "intuitive theists"—predisposed to construe natural objects as though they are nonhuman artifacts, the products of nonhuman design?

Address correspondence to Deborah Kelemen, Department of Psychology, Boston University, 64 Cummington St., Boston, MA 02215; e-mail: dkelemen@bu.edu.

PROMISCUOUS TELEOLOGY AND "CREATIONISM" IN CHILDREN

Contemporary research on teleological reasoning—the tendency to reason about entities and events in terms of purpose—was initiated in the context of the debate on the origins of biological understanding. Consistent with the view that children's reasoning about living things is constrained by teleological assumptions from a very early age, studies have found that young children attend to shared functional adaptation rather than shared overall appearance (or category membership) when generalizing behaviors to novel animals (Kelemen, Widdowson, Posner, Brown, & Casler, 2003), judge whether biological properties are heritable on the basis of their functional consequences rather than their origin (Springer & Keil, 1989), and explain body properties by reference to their self-serving functions and not their physical-mechanical cause (Keil, 1992; Kelemen, 2003).

Results like these lend support to the idea that a purpose-based teleological stance might, therefore, be humans' innate adaptation for biological reasoning (Atran, 1995; Keil, 1992). This conclusion has been complicated, however, by findings that children see not only the biological but also the nonbiological natural world in teleological terms. For example, when asked to identify unanswerable questions, American 4- and 5-year-olds differ from adults by finding the question "what's this for?" appropriate not only to artifacts and body parts, but also to whole living things like lions ("to go in the zoo") and nonliving natural kinds like clouds ("for raining"). Additionally, when asked whether they agree that, for example, raining is really just what a cloud "does" rather than what it is "made for," preschoolers demur, endorsing the view that natural entities are "made for something" and that is why they are here (Kelemen, 1999b).

These kinds of promiscuous teleological intuitions persist into elementary school, particularly in relation to object properties. For instance, when asked to conduct a "science" task and decide whether prehistoric rocks were pointy because of a physical process (e.g., "bits of stuff piled up for a long period of time") or because they performed a function, American 7- and 8-year-olds, unlike adults, preferred teleological explanations whether they invoked "self-survival" functions (e.g., "so that animals wouldn't sit on them and smash them") or "artifact" functions (e.g., "so that animals could scratch on them when they got itchy"; Kelemen, 1999c; but see Keil, 1992). This bias in favor of teleological explanation for properties of both living and nonliving natural objects occurs even when children are told that adults apply physical kinds of explanation to nonliving natural entities (Kelemen, 2003). In American children, the bias begins to moderate around 9 to 10 years of age, and this pattern now has been found also with British children for both object properties and, slightly less markedly, natural object wholes. These British findings are relevant because they weigh against interpretations that promiscuous teleological intuitions are a simple reflection of the relatively pronounced cultural religiosity, or religious exceptionalism (in postindustrial, international context), of the United States (see Kelemen, 2003, for discussion of religiosity differences).

So, if ambient cultural religiosity is not the obvious explanation, what does cause this promiscuous teleology? A study of responses young children receive when asking questions about nature indicates parents generally favor causal rather than teleological explanation, so current evidence suggests the answer does not lie there, at least, not in any straightforward sense (Kelemen, Callanan, Casler, & Pérez-Granados, 2002). Another hypothesis being explored in my lab is, therefore, as follows (e.g., Kelemen, 1999b, 1999c). Perhaps children's generalized attributions of purpose are, essentially, side effects of a socially intelligent mind that is naturally inclined to privilege intentional explanation and is, therefore, oriented toward explanations characterizing nature as an intentionally designed artifact—an orientation given further support by the artifact-saturated context of human cultures. Specifically, the proposal is that the human tendency to attribute purpose to objects develops from infants' core, and precociously developing, ability to attribute goals to agents (as discussed later): Initially, on the basis of observing agents' object-directed behavior, children understand objects as means to agents' goals, then as embodiments of agents' goals (thus "for" specific purposes in a teleological sense), and, subsequently—as a result of a growing understanding of artifacts and the creative abilities of agents—as intentionally caused by agents' goals. A bias to explain, plus a human predilection for intentional explanation, may then be what leads children, in the absence of knowledge, to a generalized, default view of entities as intentionally caused by someone for a purpose.

Details aside, the basic idea that children are disposed to view entities in terms of intentional design, or as "quasi-artifacts," is similar to one independently developed by Evans in her work on origins beliefs (Evans, 2000a, 2000b, 2001). Evans has found that regardless of the religiosity of their home background, children show a bias to endorse intentional accounts of how species originate. Thus, when asked questions like "how do you think the very first sun bear got here on earth?" 8- to 10-year-olds from both fundamentalist and nonfundamentalist American homes favored "creationist" accounts whether generating their own answers or rating agreement with the following responses: (a) God made it, (b) a person made it, (c) it changed from a different kind of animal that used to live on earth, or (d) it appeared (Evans, 2001). This preference was also found in 5- to 7-year-old children's agreement ratings for animate and inanimate entities. Indeed, it was only among 11- to 13-year-old nonfundamentalist children that divergence from the theist position emerged. Evans's results do not stand in isolation. Gelman and Kremer (1991) found that although American preschoolers recognize that artifacts rather than natural entities are human made, they favor God as the explanation of the origin of remote natural items (e.g., oceans). Petrovich (1997) found similar results with British preschoolers (although see Mead, 1932, on Manus children's disinclination to use supernatural explanation).[1]

Considered together, current data on children's promiscuous teleology and explanations of origins might therefore suggest an obvious affirmative answer to the question of whether children are intuitive theists: Children view natural phenomena as intentionally designed by a god. Not coincidentally, they therefore view natural objects as existing for a purpose. But before embracing, or even entertaining, this conclusion, we must look first at whether it is actually defensible. What evidence is there that children possess any of the conceptual prerequisites that intuitive theism might entail? What evidence is there that their intuitions display any coherence at all?

CONCEPTUAL PREREQUISITES TO INTUITIVE THEISM

Piaget (1929) found that when asked how natural objects originated, children frequently identified "God" as the cause. Piaget argued that these statements were simply further cases of artificialism: Unable to entertain an abstraction such as God, and egocentrically focused, children used "God" to refer to a person who was fundamentally similar to the dominant authority in children's own lives—their parent.

Once again, however, Piaget's assumptions about the concreteness of children's concepts have been challenged. Research now suggests that rather than being anthropomorphic, children's earliest concept of agency is abstract, and is invoked by a range of nonhuman entities from the time when overt signs of children's sensitivity to mental states are becoming increasingly robust. Thus, 12-month-old infants will follow the "gaze" of faceless blobs as long as they have engaged in contingent interaction with them (S.C. Johnson, Booth, & O'Hearn, 2001) and will attribute goal directedness to computer-generated shapes (e.g., Csibra & Gergely, 1998). By 15 months, infants will complete the incomplete actions of a nonhuman agent by inferring its goals (S.C. Johnson et al., 2001). From infancy, we are, then, excellent "agency detectors" (Barrett, 2000; Guthrie, 2002).

But, although relevant, these indications that children attribute mental states to perceivable nonhuman agents while watching them are still nonevidential with respect to young children's ability to reason about the creative intentions of intangible, nonnatural agents like gods. Presumably several capacities are minimally prerequisite in order to reason about such special causal agents: first, the capacity to maintain a mental representation of such an agent despite its intangibility; second, the ability to attribute to that special agent mental

[1]Mead explored attributions of consciousness to inanimate entities by children from a small-scale animist society. However, the nature of Mead's data (e.g., drawings, queries about inanimate malintentions) makes children's nonreference to supernatural agency difficult to interpret. Furthermore, although her data suggest the children were not animists, they do not rule out possible intuitive theism.

states distinguishing it from more commonplace agents; and third—and particularly pertinent to the question of nonnatural artifice—the basic ability to attribute design intentions to agents and understand an object's purpose as deriving from such intentions.

CONCEPTIONS OF INTANGIBLE AGENTS

Several lines of research are suggestive of young children's abilities regarding the first two prerequisites. First, Taylor's (1999) research on children's propensity to maintain social relationships with imaginary companions suggests that by age 3 to 4 years, children are already conceptually equipped to vividly mentally represent the wants, opinions, actions, and personalities of intangible agents on a sustained basis. Like supernatural agents, such companions are found cross-culturally and are often distinguished from more commonplace agents by special biological, psychological, and physical traits beyond invisibility. Examples are animals that talk and individuals who understand gibberish, hear wishes, or live on stars (Taylor, 1999). Interestingly, ideas about imaginary companions, like ideas about gods, can be culturally transmitted, at least, within families.[2]

Imaginary companions, then, provide some indications of young children's ability to symbolically represent and reason about immaterial individuals. But research explicitly focused on children's understanding of God has also found that by 5 years of age, children can make quite sophisticated predictions as to how a more widely recognized nonnatural agent's mental states are distinguished from those of more earthly individuals. Specifically, Barrett, Richert, and Driesenga (2001) cleverly capitalized on the well-documented shift in 3- to 5-year-olds' ability to pass false-belief tasks—tests that putatively measure children's theory-of-mind understanding that beliefs are mental representations and, as such, can mismatch with physical reality. In their study, Barrett et al. used a standard form of the task: Children were shown a cracker box, asked what they believed it contained, allowed to peek inside and see the actual contents (pebbles), and then asked the test question, What would someone (who had not been shown) believe was inside the container? As is typical in such studies, Barrett et al. found that 3-year-olds failed the test, giving an answer that, in some sense, assumes that people are all-knowing; that is, 3-year-olds answered, "pebbles." In contrast, an increasing percentage of 4- and 5-year-olds passed, saying "crackers"—an answer recognizing the fallibility of beliefs. Interestingly, however, a different pattern emerged when these Protestant-raised children were asked what God would believe. At all ages tested, children treated God as all-knowing, even when they clearly understood that earthly agents would have a false belief. This developmental pattern led Barrett et al. to provocatively suggest that children may be innately attuned to "godlike" nonhuman agency but need to acquire an understanding of the limitations of human minds. Similar results have now also been obtained with Yukatec Mayan children, who discriminated not only the Christian God but also other supernatural agents as less susceptible to false belief than people (Knight, Sousa, Barrett, & Atran, 2003; also Atran, 2002, for a description).

In sum, then, these findings suggest that around 5 years of age, children possess the prerequisites to make advanced, distinctive, attributions of mental states to nonnatural agents. But are children truly conceptually distinguishing these agents from people or just representing these agents as humans augmented with culturally prescribed, superhuman properties inferred from adults' religious talk? The answer to this question is unclear. Certainly children's supernatural concepts, like those of adults, are likely to be influenced by culturally prescribed, systematically counterintuitive properties (Atran, 2002; Boyer, 2001) and may also be anthropomorphic in many ways. But, even if children's concepts of nonnatural agency do have human features, this does not undermine the claim that children conceive of such agents as distinct: We do not question adults' capacity to conceive of supernatural agents, and yet research indicates that even when adults explicitly attribute gods with properties like omnipresence, they assume, in their implicit reasoning, that gods act in accordance with human temporal, psychological, and physical constraints (Barrett, 2000).

Even so, perhaps applying the phrase "intuitive theists" to children—given all that the term "theism" implies to adults—might seem misplaced, if not irreverent. After all, although young children might conceive of nonnatural agents and hypothesize about their mental states, presumably they do not contemplate the metaphysical "truth" of which such agents can be part, or experience emotions concomitant with endorsing a particular metaphysical-religious system. Intuitively, these assumptions seem correct although, again, there are reasons to equivocate—not only because research suggests adult religious belief systems are often not particularly coherent or contemplated (e.g., Boyer, 2001), but also because the question of when children begin to develop metaphysical understanding in the adult self-reflective sense is debated (e.g., Evans & Mull, 2002; Harris, 2000; C.N. Johnson, 2000). Specifically, although children might not explicitly demarcate their musings as special, it has been found that even from very young ages, children pose questions about the nature of things that echo adult metaphysical themes (Harris, 2000; Piaget, 1929). Furthermore, we actually know little about young children's emotions concerning self-generated or culturally derived concepts of nonnatural agency, outside of their emotional relationships with imaginary companions. Gaps in our knowledge therefore preclude general conclusions as to children's capacity to entertain adultlike religious feeling.

However, for the present purpose, such issues are, to a large extent, irrelevant because in the current context the term intuitive theist embodies no claims regarding children's emotional or metaphysical commitments. All that is under question is whether children make sense of the world in a manner superficially approximating adult theism, by forming a working hypothesis that natural phenomena derive from a nonhuman "somebody" who designed them for a purpose—an intuition that may be elaborated by a particular religious culture but derives primarily from cognitive predispositions and artifact knowledge.[3] This point circles us back to the third conceptual

[2]I do not intend to suggest that children's relationships with imaginary companions are akin to adults' relationships with gods. An important difference is that the latter are experienced as real (Boyer, 2001), whereas evidence suggests that (American) children's imaginary companions are experienced as fictions (Taylor, 1999).

[3]Some form of folk religion appears to exist in all human cultures, but not all religions are theist (e.g., animism), raising the interesting possibility that children's intuitions may sometimes mismap with the dominant adult culture's religious ideas. However, because all known folk religions involve nonnatural agents and intentional causation—the substrate of intuitive theism—such mismappings need not represent an ongoing conceptual conflict, but instead leave children's intuitions open to coexist with and be influenced by cultural religious ideas.

prerequisite for intuitive theism—children's ability to understand that an object's purpose derives from the designer's goals.

CHILDREN'S UNDERSTANDING OF ARTIFACTS AND DESIGN

Adult reasoning about artifacts is anchored by intuitions about the designer's intended function (e.g., Keil, 1989; Rips, 1989), but although behavioral measures suggest that from around 3 years of age children will teleologically treat artifacts as "for" a single privileged function (Casler & Kelemen, 2003a; Markson, 2001), the question of when children adopt an adultlike teleological construal based on reasoning about the creator's intent (the "design stance") is debated (Kelemen & Carey, in press).

One reason for the lack of consensus is studies suggesting that, until they are quite old, children apply category labels to artifacts on the basis of shared shape, not shared function (e.g., Gentner, 1978; Graham, Williams, & Huber, 1999; Landau, Smith, & Jones, 1998). Such studies have found that until around 6 years of age, children will judge that if an object looks similar to an artifact called "a wug," it is also "a wug" even though it does not do the same thing. Children's apparent indifference to what artifacts did in these categorization studies seemed to render it unlikely that the deeper principle of intended function could play much of a role in their concepts of artifacts.

However, recent findings suggest that the stimuli in earlier studies may have significantly contributed to children's categorization failures in that experimenters unnaturally dissociated artifact form from artifact function, an approach leading to uncompelling "functions" equivalent to general object properties (e.g., capacities to rattle, roll, absorb). In current research using artifacts that look designed in that their structural properties clearly relate to their functional affordances, children from around the age of 2 years have generalized labels on the basis of function rather than shape similarity (e.g., Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Kemler Nelson, Russell, Duke, & Jones, 2000). Furthermore, evidence also suggests that even when children categorize artifacts by shape, rather than being a superficial perceptual strategy, this approach reflects the valid conceptual assumption that shape predicts the creator's intent. Thus, Diesendruck, Markson, and Bloom (2003) found that if 3-year-olds have the shape similarity between two artifacts pointed out to them but then hear that the objects have different intended functions, they eschew classifying them as the same kind of artifact, instead forming categories based on shared function and perceptual dissimilarity. This shift from a shape to a function strategy happens only if children hear about *intended* functions—information about possible function is not sufficient.

These findings provide suggestive evidence that young children have a sensitivity to intended function from around the age of 3 years. They are particularly interesting when considered alongside research explicitly focused on when children weigh overt information about intended design. In studies in my own lab, this tendency is increasingly evident between ages 4 and 5 years. For example, in one study, 4- and 5-year-old children were told stories about depicted novel artifacts that were intentionally designed for one purpose (e.g., squeezing lemons), given away, and then accidentally or intentionally used for another activity (e.g., picking up snails). When asked what each object was "for," the children, like adults, favored the intended function, even in experimental conditions in which the alternative use occurred frequently rather than just once (Kelemen, 1999b). A subsequent study replicated this effect using manipulable, novel artifacts. In contrast to 3-year-olds, groups of 4- and 5-year-olds not only judged the objects as "for" their designed function rather than their everyday intentional use, but also favored intended function when judging where items belonged in a house (Kelemen, 2001).

Research by Matan and Carey (2001) also reveals some early sensitivity to intended function. In their study, children were told about artifacts that were made for one purpose (e.g., to water flowers) but used for something else (to make tea in). When asked which familiar artifact category the object belonged to (e.g., watering can or teapot), 4- and 6-year-olds, like adults, had a preference for the design category. However, 4-year-olds' tendency to be influenced by the order of forced-choice response options on some trials led Matan and Carey to conclude that an understanding of designer's intent does not organize children's artifact concepts until around 6 years of age.[4]

According to German and Johnson (2002), however, even the design bias that Matan and Carey's (2001) results did reveal offers no real indication of children's understanding of the designer's role in designating function. Instead, German and Johnson argued, naming results such as these reveal little more than children's more shallow knowledge that the designer has the right to designate an object's category name and membership ("baptism rights").

Although it is not clear that this explanation accounts for Matan and Carey's (2001) results,[5] German and Johnson's (2002) results were consistent with the notion that this is the limit of children's understanding. Using function-judgment methods similar to those used in my lab, they found that although 5-year-olds weigh designer's intent over another agent's intentional action when determining what a novel artifact's category name is, they do not reliably use designer's intent when judging what a novel object is "really for"—a lack of design-based construal that is also reflected, German and Defeyter (2000) argued, in 5-year-olds' relative success at function-based insight problem solving: Specifically, employing methods classically used to explore functional fixedness, German and Defeyter found that although 6- and 7-year-olds find it difficult to disregard an artifact's design function when asked to solve a problem creatively with it, 5-year-olds do not have this difficulty, more readily seeing how an artifact can be used unconventionally to achieve a goal (seeing a box as a platform and not a container; also Defeyter & German, 2003). Such a lack of the design stance in 5-year-olds is, in fact, no surprise, suggested German and Johnson, when the computations involved in reasoning about design intentions are actually considered; that is, design attributions require recursive reasoning about second-order mental states—"maker intends (that user intends) that X will perform Y"—something acknowledged as difficult for children.

However, this explanation of 5-year-olds' lack of design sensitivity in German and Johnson's (2002) tasks is challengeable: Design in-

[4]Matan and Carey's children made fewer design-based judgments when the design category name was presented second rather than first—an effect perhaps caused by the use of familiar artifacts as stimuli and pretrial procedures for familiarizing children with these stimuli that may have subsequently prompted prepotent responding to the first function information heard, reducing design-based reasoning overall.

[5]Half of Matan and Carey's stimuli had names encoding intended function, rendering it unlikely that participants processed only intended category membership.

tentions may not require second-order computation (they may reduce to "maker intends that user does X with Y" or "maker intends that X does Y"), and reasoning about mental-state content of a more complex form than the goal states of design intentions has been documented among 3- and 4-year-olds (e.g., Chandler, Fritz, & Hala, 1989; Siegal & Beattie, 1991). Furthermore, although in combination German and his colleagues' findings might suggest that a design-based grasp of artifact function is not present until age 6 or 7 years, some patterns across their various studies raise questions: For example, in German and Johnson's function-judgment task, even adults' tendency to judge that the novel artifacts were "really for" the designed function rather than an intended use was weak—more than half the adult subjects made design-based judgments 50% or less of the time. Perhaps, then, unintended qualities of the stimuli had a particular impact on children's judgments across all of German and Johnson's studies. Additionally, studies directly exploring whether there is a relationship between 3- to 5-year-olds' susceptibility to functional fixedness and their tendency to construe artifacts in terms of original design have found no correlation between the two abilities, suggesting that other factors (e.g., age- or education-related changes in conventionality) might account for 5-year-olds' advantage in German and Defeyter's (2000) insight tasks (Kelemen, 2001).

These disparities aside, an underlying developmental pattern does emerge across all of these studies. With some reliability, the findings suggest that beginning some time around the kindergarten period, children adopt a design-based teleological view of objects with increasing consistency. In light of this work, and the earlier-described research on children's reasoning about nonnatural agents' mental states, the proposal that children might be intuitive theists becomes increasingly viable.

However, an issue still remains: Just because children can consider objects as products of design does not mean this ability has any actual connection to children's attributions of purpose to nature. It is possible, after all, that, like some adults, children view supernatural agents as originators of nature but consider the functionality of many natural phenomena as deriving from an entirely different, nonintentional cause (e.g., evolution). Thus, although children may invoke God in their explanations of origins (e.g., Evans, 2001) and view natural phenomena as existing for a purpose (e.g., Kelemen, 1999b), the two sets of intuitions may have no systematic relation.

A recent study addressing this question suggests that this is not the case. Six- to 10-year-old British children were first asked to generate ideas about why various animals, natural objects, and events exist, and then consider other people's explanations, indicating their preference between teleological and physical explanations for each item. Subsequently, the children were also asked questions probing their ideas about intentional origins and whether they thought the earlier items originated because they "just happened" or because they were "made by someone/something." The design of the study precluded children from tracking their answers and aligning their answers to earlier and later questions in the absence of intuitions of their own. Nevertheless, the results revealed correlations between children's teleological ideas about nature and their endorsements of intentional design. Furthermore, no artificialism was found: Children identified people as the designing agents of artifacts (control items), distinguishing God as the designing agent of nature (Kelemen & DiYanni, in press).

SUMMARY

This article began by posing a question: Given findings regarding children's beliefs about purpose and their ideas about the intentional origins of nature, is it possible that children are intuitive theists insofar as they are predisposed to develop a view of nature as an artifact of nonhuman design?

A review of recent cognitive developmental research reveals that by around 5 years of age, children understand natural objects as not humanly caused, can reason about nonnatural agents' mental states, and demonstrate the capacity to view objects in terms of design. Finally, evidence from 6- to 10-year-olds suggests that children's assignments of purpose to nature relate to their ideas concerning intentional nonhuman causation. Together, these research findings tentatively suggest that children's explanatory approach may be accurately characterized as intuitive theism—a characterization that has broad relevance not only to cognitivists or the growing interdisciplinary community studying the underpinnings of religion (Barrett, 2000), but also, at an applied level, to science educators because the implication is that children's science failures may, in part, result from inherent conflicts between intuitive ideas and the basic tenets of contemporary scientific thought.

Further research is required, of course, to clarify how well the description really holds across individuals and cultures (reliable, empirical cross-cultural research is limited), how robust the orientation to purpose and design is, and how it interacts with education over time. A significant theoretical goal is to empirically discriminate the present hypothesis that children are inherently predisposed to invoke intention-based teleological explanations of nature and find them satisfying (see Bering, 2002, for a related stance) from the milder hypothesis that children's teleological orientation arises primarily from their possession of the kind of cognitive machinery (e.g., agency detection) that renders them susceptible to the religious representations of their adult culture—a position that predicts children would not independently generate explanations in terms of designing nonnatural agency without adult cultural influence.

A proper discussion of the pros and cons of each position, along with how to empirically distinguish them, is beyond the scope of this short article. However, it is worth emphasizing that the kind of research program proposed here is one that involves focusing on adults as much as children because although the question "are children intuitive theists?" implies a dichotomy between child and adult thought, the current proposal tacitly assumes that the idea of such a fundamental dichotomy is false: If, as suggested here, the tendency to think in teleological quasi-artifact terms is a side effect of human mental design (and pan-cultural experience with artifacts) rather than socialization, it is likely to remain as a default explanatory strategy throughout life, even as other explanations are elaborated. This idea contrasts with the notion that through conceptual change (e.g., Carey, 1985), such an explanatory approach is revised and replaced by a physical-reductionist view of nature in cultures endorsing such ideas.

Several factors provide support for this suggestion of developmental continuity. First, reasoning about all aspects of nature in nonteleological physical-reductionist terms is a relatively recent development in the history of human thought (see Kelemen, 1999a, for a brief history of the "design argument"), and contemporary adults are still surprisingly bad at it. For example, evolution is generally misconstrued as a quasi-intentional needs-responsive designing force, indicating

that even when adults elaborate alternative scientific explanations, signs of intention-based reasoning about nature are still in evidence (see Evans, 2000a, for review). Second, recent research with American college undergraduates has found that although such populations endorse teleological explanation in a selective, scientifically appropriate way in the evaluative context of a forced-choice "scientific" experiment, in a less evaluative environment they will more promiscuously generate teleological explanations of why animals and inanimate natural objects exist. These results suggest that even in a post-Darwinian culture, continuity rather than conceptual change may be at play in educated individuals' preference for teleological explanation (Kelemen, 2003). Finally, and significant to the conjecture that scientific educations suppress rather than replace teleological explanatory tendencies, research with scientifically uneducated Romanian Gypsy adults has found that they have promiscuous teleological intuitions much like scientifically naive British and American elementary-school children (Casler & Kelemen, 2003b). In conclusion, the question of whether children and adults are intuitive theists provides fertile ground for future research.

Acknowledgments—This work was supported by National Institutes of Health Grant HD37903-01. I thank Justin Barrett, Krista Casler, Cara DiYanni, Liz Donovan, and an anonymous reviewer for very helpful comments on earlier drafts. Special thanks go to Kim Saudino.

REFERENCES

Atran, S. (1995). Causal constraints on categories. In D. Sperber, D. Premack, & A.J. Premack (Eds.), *Causal cognition: A multi-disciplinary debate* (pp. 263–265). Oxford, England: Clarendon Press.

Atran, S. (2002). *In gods we trust: The evolutionary landscape of religion*. New York: Oxford University Press.

Baillargeon, R. (1993). The object concept revisited: New directions in the investigation of infants' physical knowledge. In C.E. Granrud (Ed.), *Visual perception and cognition in infancy* (Carnegie Mellon Symposia on Cognition Vol. 23, pp. 265–315). Hillsdale, NJ: Erlbaum.

Barrett, J.L. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, *4*, 29–34.

Barrett, J.L., Richert, R., & Driesenga, A. (2001). God's beliefs versus mother's: The development of non-human agent concepts. *Child Development*, *72*, 50–65.

Bering, J. (2002). Intuitive conceptions of dead agents' minds: The natural foundations of afterlife beliefs as a phenomenological boundary. *Journal of Cognition and Culture*, *2*, 263–308.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. New York: Basic Books.

Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.

Casler, K., & Kelemen, D. (2003a). *Teleological explanations of nature among Romanian Roma (Gypsy) adults*. Unpublished manuscript, Boston University, Boston.

Casler, K., & Kelemen, D. (2003b). *Tool use and children's understanding of artifact function*. Unpublished manuscript, Boston University, Boston.

Chandler, M., Fritz, A.S., & Hala, S. (1989). Small-scale deceit: Deception as a marker of two-, three-, and four-year-olds' early theories of mind. *Child Development*, *60*, 1263–1277.

Csibra, G., & Gergely, G. (1998). The teleological origins of mentalistic action explanations: A developmental hypothesis. *Developmental Science*, *1*, 255–259.

Defeyter, M., & German, T. (in press). Acquiring an understanding of design: Evidence from children's insight problem-solving. *Cognition*.

Diesendruck, G., Markson, L.M., & Bloom, P. (2003). Children's reliance on creator's intent in extending names for artifacts. *Psychological Science*, *14*, 164–168.

Evans, E.M. (2000a). Beyond Scopes: Why Creationism is here to stay. In K.S. Rosengren, C.N. Johnson, & P.L. Harris (Eds.), *Imagining the impossible: The development of magical, scientific and religious thinking in contemporary society* (pp. 305–333). Cambridge, England: Cambridge University Press.

Evans, E.M. (2000b). The emergence of beliefs about the origin of species in school-age children. *Merrill Palmer Quarterly*, *46*, 221–254.

Evans, E.M. (2001). Cognitive and contextual factors in the emergence of diverse belief systems: Creation versus evolution. *Cognitive Psychology*, *42*, 217–266.

Evans, E.M., & Mull, M. (2002). *Magic can happen in that world (but not this one): Constructing a naïve metaphysics*. Manuscript submitted for publication.

Gelman, S.A., & Kremer, K.E. (1991). Understanding natural cause: Children's explanations of how objects and their properties originate. *Child Development*, *62*, 396–414.

Gentner, D. (1978). What looks like a jiggy but acts like a zimbo? A study of early word meaning using artificial objects. *Papers and Reports on Child Language Development*, *15*, 1–6.

German, T., & Defeyter, M. (2000). Immunity to functional fixedness in young children. *Psychonomic Bulletin & Review*, *7*, 707–712.

German, T., & Johnson, S.A. (2002). Function and the origins of the design stance. *Journal of Cognition and Development*, *3*, 279–300.

Graham, S.A., Williams, L.D., & Huber, J.F. (1999). Preschoolers' and adults' reliance on object shape and object function for lexical extension. *Journal of Experimental Child Psychology*, *74*, 128–151.

Guthrie, S. (2002). Animal animism: Evolutionary roots of religious cognition. In I. Pyysiainen & V. Anttonen (Eds.), *Current approaches in the cognitive science of religion* (pp. 38–67). London: Continuum.

Harris, P. (2000). On not falling down to earth: Children's metaphysical questions. In K.S. Rosengren, C.N. Johnson, & P.L. Harris (Eds.), *Imagining the impossible: The development of magical, scientific and religious thinking in contemporary society* (pp. 157–178). Cambridge, England: Cambridge University Press.

Johnson, C.N. (2000). Putting different things together: The development of metaphysical thinking. In K.S. Rosengren, C.N. Johnson, & P.L. Harris (Eds.), *Imagining the impossible: The development of magical, scientific and religious thinking in contemporary society* (pp. 179–211). Cambridge, England: Cambridge University Press.

Johnson, S.C., Booth, A., & O'Hearn, K. (2001). Inferring the goals of a nonhuman agent. *Cognitive Development*, *16*, 637–656.

Keil, F.C. (1989). *Concepts, kinds, and cognitive development*. Cambridge, MA: MIT Press.

Keil, F.C. (1992). The origins of an autonomous biology. In M.R. Gunnar & M. Maratsos (Eds.), *Minnesota Symposia on Child Psychology: Vol. 25. Modularity and constraints in language and cognition* (pp. 103–137). Hillsdale, NJ: Erlbaum.

Kelemen, D. (1999a). Beliefs about purpose: On the origins of teleological thought. In M. Corballis & S. Lea (Eds.), *The descent of mind: Psychological perspectives on hominid evolution* (pp. 278–294). Oxford, England: 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*, 1440–1453.

Kelemen, D. (2001, April). *Intention in children's understanding of artifact function*. Paper presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, MN.

Kelemen, D. (2003). British and American children's preferences for teleofunctional explanations of the natural world. *Cognition*, *88*, 201–221.

Kelemen, D., Callanan, M., Casler, K., & Pérez-Granados, D. (2002). *"Why things happen": Teleological explanation in parent-child conversations*. Manuscript submitted for publication.

Kelemen, D., & Carey, S. (in press). The essence of artifacts: Developing the design stance. In S. Laurence & E. Margolis (Eds.), *Creations of the mind:*

Theories of artifacts and their representation. Oxford, England: Oxford University Press.

Kelemen, D., & DiYanni, C. (in press). Intuitions about origins: Purpose and intelligent design in children's reasoning about nature. *Journal of Cognition and Development*.

Kelemen, D., Widdowson, D., Posner, T., Brown, A., & Casler, K. (2003). Teleofunctional constraints on preschool children's reasoning about living things. *Developmental Science*, *6*, 329–345.

Kemler Nelson, D.G., Frankenfield, A., Morris, C., & Blair, E. (2000). Young children's use of functional information to categorize artifacts: Three factors that matter. *Cognition*, *77*, 133–168.

Kemler Nelson, D.G., Russell, R., Duke, N., & Jones, K. (2000). Two-year-olds will name artifacts by their functions. *Child Development*, *71*, 1271–1288.

Knight, N., Sousa, P., Barrett, J.L., & Atran, S. (in press). Children's attributions of beliefs to humans and God: Cross cultural evidence. *Cognitive Science*.

Landau, B., Smith, L.B., & Jones, S.S. (1998). Object shape, object function, and object name. *Journal of Memory and Language*, *38*, 1–27.

Markson, L.M. (2001, April). *Developing understanding of artifact function*. Paper presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, MN.

Matan, A., & Carey, S. (2001). Developmental changes within the core of artifact concepts. *Cognition*, *78*, 1–26.

Mead, M. (1932). An investigation of the thought of primitive children with special reference to animism. *Journal of the Royal Anthropological Institute of Great Britain and Ireland*, *62*, 173–190.

Petrovich, O. (1997). Understanding of non-natural causality in children and adults: A case against artificialism. *Psyche and Geloof*, *8*, 151–165.

Piaget, J. (1929). *The child's conception of the world*. London: Routledge & Kegan Paul.

Rips, L.J. (1989). Similarity, typicality and categorization. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 21–59). Cambridge, England: Cambridge University Press.

Siegal, M., & Beattie, K. (1991). Where to look first for children's knowledge of false beliefs. *Cognition*, *38*, 1–12.

Springer, K., & Keil, F.C. (1989). On the development of biologically specific beliefs: The case of inheritance. *Child Development*, *60*, 637–648.

Taylor, M. (1999). *Imaginary companions and the children who create them*. New York: Oxford University Press.

(Received 2/21/03; Revision accepted 5/1/03)