

# Intuitions About Origins: Purpose and Intelligent Design in Children’s Reasoning About Nature

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Two separate bodies of research suggest that young children have (a) a broad tendency to reason about natural phenomena in terms of a purpose (e.g., Kelemen, 1999c) and (b) an orientation toward “creationist” accounts of natural entity origins whether or not they come from fundamentalist religious backgrounds (e.g., Evans, 2001). This study extends this prior work to examine whether children’s purpose-based reasoning about nature is actively related to their intelligent design reasoning in any systematic fashion. British elementary school children responded to 3 tasks probing their intuitions about purpose and intelligent design in context of their reasoning about the origins of natural phenomena. Results indicated that young children are prone to generating artifact-like teleo-functional explanations of living and nonliving natural entities and endorsing intelligent design as the source of animals and artifacts. They also reveal that children’s teleo-functional and intelligent design intuitions about natural phenomena are interconnected.

Piaget’s (1929) famous claim that children are artificialists, who lack a sense of physical causality, and therefore draw on their subjective intentional experience to conclude that all things are made by people has received scrutiny over the last few decades. Contrary to Piaget’s assertion of profound child–adult incommensurability, contemporary findings based on developmentally sensitive methods now suggest that children reason in physical–causal terms from infancy (Baillargeon, Spelke, & Wasserman, 1985; Leslie, 1982; Shultz, 1982; Spelke, 1991) and that they distin-

guish between inanimates and animates along many dimensions (e.g., Carey, 1985; Massey & R. Gelman, 1988), recognizing, most critically, that people make artifacts but not natural kinds (e.g., Gelman & Kremer, 1991; Gelman & Markman, 1987; Keil, 1989; Petrovich, 1997). However, subsequent to studies highlighting Piaget's inaccuracies with regard to children's beliefs about human creative power, relatively little contemporary research has attempted to further elaborate the structure of children's reasoning about origins in nature (Evans, 1994, 2000a, 2000b, 2001; Samarapungavan & Weirs, 1997). This is despite the fact that the topic bears on the interesting issue of how children construe different categories and also how children begin to approach questions that, for adults, fall within the realm of metaphysical reflection (Bering, 2002; Evans & Mull, 2002; Harris, 2000; Johnson, 2000).

This study examines children's ideas relating to origins and is motivated, in part, by recent research suggesting that at least one aspect of Piaget's artificialism proposal should not be dismissed. Consistent with Piaget's claim, there are now a growing number of studies indicating that children have a broad teleo-functional bias to treat objects and behaviors of all kinds as existing for a purpose (Donovan & Kelemen, 2003; Kelemen, 1999b, 1999c, 2003d; but see Keil 1992, 1994; Kerner, 2003). This article examines children's intuitions about origins with a view to exploring why this might be so. But, before turning to the specific issue of origins, what is the evidence that children possess the kind of bias toward teleo-functional reasoning just described?

The contemporary evidence derives from studies conducted with preschoolers and elementary school children by Kelemen (1999b, 1999c, 2003; for discussion of greater selectivity, see Keil, 1992, 1994, 1995; Kelemen, 1999a). For example, in one study, American adults and 4- and 5-year-olds were asked what living things, artifacts, nonliving natural objects, and their properties were "for" while explicitly being given the option of saying they were not "for" anything. Even though both age groups demonstrated a capacity to withhold function-based answers, adults selectively ascribed functions to biological parts (e.g., ears) and artifacts (e.g., clocks) but children assigned a function to almost every kind of object and object part (e.g., mountains, "for climbing"; clouds, "for raining"; lions "for to go in the zoo"). A follow-up task employing a forced choice method reconfirmed this pattern in preschoolers and established that children viewed these activities as what the objects were "made for" (Kelemen, 1999c). An additional task also found evidence that a bias toward purpose (dubbed "Promiscuous Teleology") occurs with elementary school aged children—at least in relation to their reasoning about object properties (Kelemen, 1999d). For instance, when asked to choose between different teleo-functional versus physical-reductionist explanations of the properties of prehistoric animals (e.g., flat feet on mammals) and nonliving natural objects (e.g., points on rocks), American adults eschewed teleo-functional explanations except when asked about biological properties. In contrast, children under 10 years selected teleo-functional explanations as often for living as nonliving natural

object properties, endorsing ideas such as “the sand was grainy so that animals could easily bury their eggs in it,” over “it was grainy because bits of shells got broken and mixed up making it that way,” on average, around 70% of the time. This pattern of results has now also been found with British elementary school children who do not significantly differ from American children in their tendency to extend teleo-functional explanations to nonbiological natural properties despite the lower religiosity level of British culture at large (Kelemen, 2004).

These findings are interesting particularly when considered in relation to recent work by Evans. In a comprehensive set of studies, Evans (1994, 2000a, 2001) has found that regardless of whether they are from Christian fundamentalist or nonfundamentalist backgrounds, Midwestern American children are biased to endorse intentional accounts of how species originate. Thus, when asked questions such as “How do you think the very first sun-bear got here on earth?” 8- to 10-year-olds from both religious and nonfundamentalist backgrounds favored “creationist” accounts of animal origins whether the questions were open-ended or involved rating agreement to answers such as (a) God made it, (b) a person made it, (c) it changed from a different kind of animal that used to live on earth, and (d) it appeared; it came out of the ground (Evans, 2001). The tendency for both groups of children ranged around 67% to 73% with open-ended questions and 94% to 98% with closed-ended questions. Furthermore, it also extended into the earlier years. For example, even though 5- to 7-year-old nonfundamentalist children were less consistent than fundamentalist children in answering open-ended questions—generating creationist and spontaneous generationist accounts with equal frequency—when asked closed-ended questions, children from both communities strongly endorsed creationist explanations for animate and inanimate entities (approximately 88%–95% creationist endorsement). Only 11- to 13-year-olds, the oldest group of nonfundamentalist children, showed any marked tendency to deviate from the creationist position, voicing the dominant beliefs of their background community, which happened to be mixed creationist and evolutionist.

Of course, although generated separately, considered together Kelemen’s and Evans’ findings suggest that, in a modified form, Piaget’s general artificialism claim holds some truth: Children have a tendency to ascribe purpose to nature and this is connected to their ideas about intentional design. That is, in some sense, children tend to view natural phenomena as though they are artifacts, albeit artifacts that, contrary to Piaget, children do not view as human made.

This interpretation, that children employ an artifact model as a basis for explanation, is one that both Kelemen and Evans (e.g., Evans, 1994, 2000a; Kelemen, 1999a, 1999b) have speculated as the source of their respective results, although at the same time both dissenting from the Piagetian view that children’s tendencies result from a “precausal” conceptual system that does not differentiate intentional from physical cause. A counter proposal is that children’s orientation to teleo-

functional and creationist explanation results, not from children's incompetence at physical causal reasoning but rather from their particular sensitivity to intentionality. Specifically, there is evidence to suggest that people may be intrinsically disposed to invoke agency and intentional explanation in situations of uncertainty, or in the absence of knowledge (Barrett, 2000; Guthrie, 1993, 2002; Kelemen, 1999a). In light of this, Kelemen (1999c, 1999b) has outlined an account hypothesizing that the teleo-functional construal may have complex developmental links to an understanding of intentionality in at least two ways: first, with respect to its conceptual origins and second, with respect to its scope.

In relation to origins, the suggestion is that the tendency to view an entity as "for" a purpose derives from children's early emerging ability to interpret agents' behavior as goal-directed (e.g., S. Johnson, 2000; Tomasello, 1999; Woodward, 1998). In particular, young children's sensitivity to the way agents use objects as means to achieve goals may provoke a rudimentary teleo-functional view of entities as those goals shift from being construed as properties of agents' minds to being construed as intrinsic properties of the instrumental objects themselves—a shift that leads the objects' existence, properties and identity to become rationalized in terms of their functional utility or intentional use (Kelemen, 1999b, 2004; Kelemen & Carey, 2003). Because children exist in artifact-saturated environments, and because artifacts and their properties are readily explained by the uses to which they are put, this proposal predicts that a teleo-functional construal of artifacts will be particularly developmentally privileged. Furthermore, it suggests that the initial, relatively shallow, teleo-functional construal—which rationalizes objects in terms of their intentional use—will readily deepen into one based on an understanding of intended designed function (a.k.a., "the design stance"; Dennett, 1990), given children's ample opportunity to observe and engage in goal-directed activities related to artifact manufacture (e.g., drawing, food preparation, construction). Indeed, the design stance that artifacts are "for" the activity that they were created to perform regardless of their everyday intentional use has been documented as early as 4 and 5 years of age (Kelemen, 1999c, 2004; Kelemen & Carey, 2003; Kemler Nelson, Herron, & Morris, 2002), with recent results suggesting an even earlier sensitivity (Diesendruck, Markson, & Bloom, 2003; DiYanni & Kelemen, 2003; but for later estimates see Defeyter & German, 2003; German & Johnson, 2002; Matan & Carey, 2000; see Kelemen & Carey, 2003, for review).

These early insights into the intention-based domain of artifacts have subsequent implications for the scope of children's teleo-functional intuitions. As mentioned earlier, in conditions of uncertainty, people seem disposed to compensate for explanatory gaps by reference to intentional explanation. In consequence, when making sense of unexplained aspects of their experience (e.g., natural phenomena), it is possible that children do more than simply view objects as existing for useful purposes. Instead, they may draw on their intention-based design stance to more richly construe objects as existing for *intentionally designed* purposes (Kelemen, 1999a, 1999b, 1999c, 1999d).

This account represents only one suggestion as to how children's promiscuous teleo-functional ideas might develop but it is detailed here because it makes the definite prediction that, in considerations of nature, children's notions of purpose and nonhuman intentional design will be fundamentally linked. However, although there is a certain commonsense appeal to the idea that purpose and design intuitions about nature are conceptually coupled, there is certainly no necessity for the account to be true: First, any existing evidence for a connection is entirely speculative. Piaget liberally extrapolated across different children's interview statements and Evans' and Kelemen's results are not only independent of each other but address subtly different questions: Evans' explored children's causal beliefs about very first origins and Kelemen's explored teleological explanations of more proximal, ongoing, states-of-affairs. Second, there need not be any logical or practical connection between intuitions about purpose and intuitions about design. For example, consistent with the proposals of some scholars, children's teleo-functional intuitions might reflect an infeasible, innate, cognitive bias, that is present from birth and entirely autonomous from other explanatory mechanisms (Atran, 1994, 1995; Keil, 1992, 1994, 1995). If such an account is correct, and teleo-functional intuitions are unformulated in relation to any integrated explanatory scheme, then a reasonable prediction is that intuitions about purpose should be relatively uncorrelated with ideas about intentional design, with any association occurring inconsistently, at best, because of post hoc theory-building by individual children. Alternatively, it may be that children's ideas about purpose in nature have no explicit link to intuitions about intentional design because they are instead linked to other kinds of intuitions. Specifically, for many adults, although it is undoubtedly the case that entities such as feet and ears exist and originated to serve a purpose, such assumptions are explicitly connected to lay ideas about a nonintentional physical process (e.g., evolution, spontaneous generation). Even though such ideas are usually erroneous according to any formal scientific perspective on natural mechanisms (Brumby, 1985; Greene, 1990; Kelemen, 1999a), they nevertheless provide an explanatory framework that is, at least superficially, nonintentional in form (e.g., birds came into existence through differential reproduction to fill an ecological need like insect regulation).

These are just two of the reasons why children's broad ideas about purpose might be entirely unrelated to ideas about intentional design. The goal of this research was, therefore, to preliminarily examine whether any form of explicit connection does exist by exploring elementary school children's reasoning about purpose and intelligent design across three different tasks concerned with the origins of natural phenomena. Elementary school rather than preschool children were chosen as participants because of their greater ability to meet the various linguistic demands of the tasks and also, perhaps, entertain as metaphysical, questions that are metaphysical from an adult perspective, although this latter ability was neither prerequisite nor assumed (e.g., Evans & Mull, 2002; Harris, 2000; Johnson, 2000).

This study also extended prior research on children's reasoning about origins and purpose in at least four additional ways. First, research on teleo-functional explanation during the elementary school years has primarily focused on reasoning about object properties. This research therefore explored 6- and 10-year-old children's reasoning about whole natural entities (and also events) given that features like bird's feathers might be explained quite differently than birds themselves. Second, research on elementary school children's teleo-functional reasoning has generally employed forced choice methods involving teleo-functional explanations generated by others (Keil, 1992; Kelemen, 1999d; but see Donovan & Kelemen, 2003). Therefore, this study explores whether children who endorse teleo-functional explanations by others are also likely to generate them for themselves for, if they do, it suggests a broader preference for the teleo-functional explanatory form that is not tied to specifics. Third, in the past, children's intuitions about origins have usually been elicited with "how" questions which are unambiguous requests for causal explanation (e.g., "how did the first ever animal get here on the earth?"; Evans, 1994, 2000a; Petrovich, 1997; Piaget, 1929; Samarapungavan & Weirs, 1997). Because teleological responses are semantically inconsistent with this form of question, this approach has set pragmatic limits on the kinds of answers children might offer. This research therefore used "why" questions (e.g., "why did the first ever X exist?") because they can be interpreted as requests for causal or teleo-functional explanation depending on the listener's construal of the phenomenon under question. Support for this assertion is provided by the finding that Western-educated adults robustly interpret "why" questions about animal properties as requests for teleo-functional explanation but "why" questions about inanimate properties as requests for physical explanation. Finally, most of the small body of contemporary research relating to children's origins ideas has been conducted with American samples (e.g., Evans, 2000a, 2000b, 2001; Gelman & Kremer, 1991; Gelman & Markman, 1987; Keil, 1989; but see Petrovich, 1997; Samarapungavan & Weirs, 1997). In the interests of diversifying, this study employed a sample from England, a country whose national population has, in recent history, displayed increasingly low overall levels of religiosity (De Graaf & Need, 2000; Kelemen, 2003; Kelley & De Graaf, 1997; Verweij, Ester, & Nauta, 1997). In light of this cultural trend, British children's tendencies to give voice to teleo-functional and intelligent design responses were therefore of some interest.

## METHOD

### Participants

Fifty-five children participated in the study. There were thirty-one 6- and 7-year-olds (17 boys and 14 girls; range = 6 years 8 months to 7 years 9 months;  $M = 7$

years, 3 months) and twenty-four 9- and 10-year-olds (14 boys and 10 girls; range = 9 years 9 months to 10 years 3 months;  $M = 10$  years, 3 months). The children were attending Year 2 and Year 5, respectively, (equivalent to Grades 1 and 5 in the United States) of two government-funded schools situated in West London.

Consistent with the diversity of London, the participants represented a broad ethnic and cultural mix. The children were identified by parents as having the following kinds of racial or ethnic descent: European or British (Overall: 30%; Year 2: 23%, Year 5: 38%), African or Caribbean (Overall: 20%; Year 2: 26%, Year 5: 13%), Mixed Race (Overall: 20%; Year 2: 23%, Year 5: 17%), Arabic (Overall: 11%; Year 2: 13%, Year 5: 8%), South Asian (Overall: 9%; Year 2: 13%, Year 5: 4%), Latin American (Overall: 4%; Year 2: 4%, Year 5: 4%), Data Unavailable (Overall: 7%; Year 2: 0%, Year 5: 17%). All children had been raised in Britain and all, bar one, had been born there. Consistent with the catchment areas for both schools, the children represented a predominantly low to low-middle income sample.

Data available from school records indicated that, at least nominally, parents identified the child sample as having the following religious makeup: 40% Christian or Roman Catholic, 31% Muslim, 11% explicitly no religion, 5% Hindu, 13% Data Unknown. To respect parents' privacy on a sensitive topic, and thus also optimize the likelihood that we would get parental consent for this study, parents were not asked to provide more detailed personal information on their own religious practices and on the level of religious training they were giving to their child. In consequence, the degree to which child participants were actively engaged in religious practice or religious education is unknown. However, some insight into cultural trends can be provided by the findings of the British Attitudes and National Opinion Research Surveys. These indicate that although 79% of American adults in their prime childrearing years (18- to 34-year-old adults) identify as having some degree of religious conviction, the same is true of only 25% of British adults who are more likely (42%) to actively label themselves as nonreligious (reported in Bruce, 1999; Kelemen, 2003). Despite these levels of conviction, when asked, British adults will still identify a religious tradition to which they are, at least, nominally affiliated.

## Materials

The stimuli used were eight laminated photographs of two artifacts (a hat and a boat), two animals (a bird and a monkey), two natural events (a thunderstorm and a flood), and two nonliving natural objects (a mountain and a river). All responses to open-ended questions were recorded on a handheld tape recorder and subsequently transcribed. Testing sessions took approximately 20 min to complete and children received a small gift for their participation.

## Design and Procedure

Children were first told that the experimenter was going to ask them their beliefs about all kinds of different things. They were then assured as follows:

For many of the questions I am going to ask, it's not certain that anybody really knows an answer—not adults, nobody. All people can do when they think about these things is say what they think is the truth—what their best guess is. That is what I want you to do. Give your best idea. So, some answers you may be very sure about and you'll know the truth. But if there's something you don't know for sure, just tell me what your best idea or guess is—what you really think is most likely to be true. After we've done that, I'd like you to listen to some other people's best guesses and tell me what you think about them.

Children then proceeded through the three parts of the study: the open-ended origins questions (e.g., why did the first ever thunderstorm occur?), closed-ended origins-teleology questions which were the same as open-ended origins questions but presented teleo-functional versus physical–reductionist response options (see Appendix A), and, finally, the closed-ended intelligent design questions (e.g., “Did someone or something make the first ever thunderstorm occur or did it just happen?”). These task components were always presented in the same order to avoid closed-ended question options contaminating children's responses to open-ended questions and closed-ended questions about intelligent design contaminating responses to closed-ended origins-teleology questions because, at least among adults, purpose can occur without intelligent action but intelligent action tends to imply purpose.

*Open-ended origins questions.* The experimenter asked the same basic open-ended question about each of the eight depicted items. The order of inquiries (thunderstorm, bird, river, monkey, mountain, flood, boat, hat) was the same for each child with artifacts placed last to avoid likely teleo-functional or human design responses to these items contaminating responses to any natural category items. The experimenter would begin each test item by asking, “Do you know what an X is?” She would then show the child a picture, explaining or confirming that this was what the item could look like and then say, “Here's the question. Why did the first ever X exist?” The word *exist* was also paraphrased for every child (e.g., “Why did the first ever bird come to be here?” “Why did it happen?”) and for the event items the word *occur* was used rather than *exist*. If children hesitated, replied that they did not know, or provided nonanswers (e.g., descriptions of the pictures, irrelevant comments, or claims that the “first ever” entity came from its mother or father), then the question was repeated (e.g., “OK, but why did the first *ever* bird

come to exist?"). Children were also reminded that they should just give their best guess because no one necessarily knows the right answer. In cases where responses were unclear, the child was asked to clarify (e.g., "Can you say that again for me? I'm not sure I understand"). If the child continued to give a "don't know" or non-response to a follow-up probe, the experimenter moved on to the next item. However, because children were reassured that all they had to do was hazard their best guess, final "don't know" or non-responses were extremely rare. Out of 55 children, there was never actually a case of a child giving a "don't know" or non-response to both items in a category pair. Four children (Year 2: 1 child, Year 5: 3 children) gave nothing beyond a "don't know" response when asked about one of their natural event items, 4 children (Year 2: 2 children, Year 5: 2 children) gave nothing beyond a "don't know" response to one of their animal items and 2 children (Year 2: 1 child, Year 5: 1 child) offered nothing beyond "don't know" to one of their natural object items.

*Closed-ended origins-teleology questions.* After completion of the open-ended origins questions, children were then told that some other people had been asked the same questions that they had just been asked, and that for each item, they would hear the ideas of two other people, and they should pick which one sounded best to them. Children were reminded that these were the best guesses of other people, so although they might not necessarily agree with the answers, they should still try to decide which one sounded better to them while registering any disagreement. Children also were encouraged to ask the experimenter to repeat either or both of the two choices if they could not remember them.

For each of the eight items (e.g., for the thunderstorm), they were then shown the relevant picture again and presented with a physical-reductionist explanation of origins (e.g., "The first ever thunderstorm occurred because some cold and warm air all rubbed together in the clouds") and a teleo-functional explanation of origins (e.g., "The first ever thunderstorm occurred to give the earth water so everything would grow"). For all items, the teleo-functional explanation described a function that was "other serving" insofar as the beneficiary of the activity was external to the object itself. In consequence no "self serving" functions of the variety "the first ever monkey existed so that it could walk, eat, reproduce, swing through trees" (i.e., experience life) were ever presented. In the case of the natural entities and events, to avoid provoking artificialism, the "other serving" functions that were described occurred for the benefit of the earth or other parts of nature rather than for human purposes. The only items to invoke a human beneficiary were the artifacts. All physical-reductionist explanations invoked feasible causal mechanisms.

The physical explanation was presented first for half of the items and presented second for the other half and item explanation order was counterbalanced

across two groups of children. The possible score range per entity or event category was 0 to 2.

*Intelligent design questions.* Finally, children were presented with the pictures of the eight items (in the same order) and told, for example, “So we’ve been talking about mountains. Now here’s the question. Did someone or something make the first ever mountain exist or did it just happen?” It should be noted that by taking this form, the question not only offered children the chance to endorse intelligent design (“someone”) or spontaneous or random generation (“just happens”) but also a nonintelligent causal antecedent (“something”). This third option was considered an important inclusion to ensure that children who had earlier described a nonintentional causal process in the first task would not be drawn into endorsing the idea of intentional agency simply because they found the wording that entities or events “just happen” unsatisfactory. It also allowed for the vague possibility that some children might, like some adults, prefer to describe a designing agent as an abstract spiritual force (i.e., “a something” rather than “a someone”). This second eventuality never occurred but several children did favor the “something made it exist” over the “it just happened” phrasing because they found the latter response inadequate and wanted to be specific about their identification of a nonintentional physical–causal antecedent. Such responses were combined with “just happen” responses for purposes of analysis. In terms of counterbalancing, the order of answer options for the intelligent design questions was reversed for half children’s items and this reversal was also counterbalanced across two groups of children. If the child responded that “someone” or “something” caused the entity to occur, then they were prompted to specify who or what was the cause of the entity’s origin and their response was noted. The possible score range per entity or event category was 0 to 2.

## RESULTS

Responses to open-ended origins questions were coded by answering two broad questions about children’s responses: Is there an intentional agent that caused the entity or event? Does the entity or event exist to serve some function? Using this approach, four coding categories were created that captured children’s responses and formed the basis for comparison to children’s responses to closed-ended origins-teleology questions: (a) Purpose (“Teleo-Functional”); (b) Agent (“Agency”); (c) Mechanism (e.g., physical-mechanical or evolutionary; “Physical-Reductionist”); and (d) Don’t know, nonexplanations, descriptions, uncodable (“Other”). Answers involving agents were also subcoded for the agent’s identity (a) God, (b) person, (c) anthropomorphised nature or earth (e.g., “Mother Nature”), and (d) indeterminate agent (i.e., “someone,” “they,” “he,” “she”). Chil-

dren's answers to open-ended questions could be assigned multiple codes. For example, the response that the first ever boat existed "so people could get carried from place to place and people made them to get carried from place to place" was assigned agency and teleo-functional codes with the agent coded as "person." Similarly, when asked about the first ever thunderstorm, the response "I don't know. It's probably a matter of God" was assigned both Other ("Don't Know") and Agency codes with the agent coded as "God." The possibility of multiple codes meant that despite being asked about two entities or events per category, children's score did not range 0 to 2 but in some extreme cases ranged from 0 to 5. Mean numbers of codes per category (including "Other") are presented in Table 1. Intercoder reliability between two coders was determined for 50% of the data and was extremely high: Cohen's  $\kappa = .92$ . Examples of the different kinds of answers children offered are in Appendix B.

Analyses of children's mean response tendencies in each of the three tasks are presented first, followed by analyses of the correlations between responses to the different tasks. With respect to analyses of variance (ANOVAs), violations of the sphericity assumption were found in a few cases. These effects were checked with the Greenhouse-Geisser correction, and in all cases, the effects remained highly significant. Therefore, they are reported in the following sections. Bonferroni adjustments were made in cases of repeated post hoc comparisons. Where study means are reported in the text, standard deviations follow in brackets.

*Open-ended origins questions.* Children's spontaneous explanatory tendencies to open-ended origins questions were first explored in a 2 (grade: Year 2, Year 5)  $\times$  3 (explanation type: Agency, Teleo-Functional, Physical-Reductionist)  $\times$  4 (item type: natural events, nonliving natural objects, animals, artifacts) ANOVA with explanation and item type as repeated measures. This analysis yielded no effect of grade but a main effect of explanation type,  $F(2, 106) = 17.41, p < .01$ , which was subsumed in an Item  $\times$  Explanation interaction,  $F(6, 318) = 27.30, p < .01$ .

As the means in Table 1 indicate, this interaction occurred because although there was no difference in children's tendency to generate agency explanations across different entity or event types, Teleo-Functional explanations did differ across categories: Children generated Teleo-Functional explanations more for artifacts than for either the nonliving natural objects or the animals but they were significantly more likely to give purpose-based explanations to all of the previous categories than to the natural events that were most likely to elicit Physical-Reductionist explanations—a form of explanation that artifact items never elicited and animals and natural objects elicited relatively rarely, all significant  $t$  tests,  $p < .001$ . A similar pattern was also reflected within each item category type. Children favored Physical-Reductionist explanations over both Teleo-Functional and Agency explanations for natural events but, consistent with earlier studies documenting

TABLE 1  
Mean Frequency of Responses to Open-Ended Origins Questions About Each Category

<i>Item Type</i>	<i>Grade</i>	<i>Agency</i>		<i>Teleology</i>		<i>Physical</i>		<i>Other</i>	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Natural events <sup>a</sup>	Year 2	0.52	0.8	0.65	0.7	0.97	0.7	0.45	0.6
	Year 5	0.42	0.6	0.29	0.5	1.25	0.8	0.42	0.6
	Total	0.47	0.7	0.49	0.6	1.09	0.8	0.44	0.6
Natural objects <sup>b</sup>	Year 2	0.65	0.8	1.13	0.8	0.48	0.7	0.32	0.5
	Year 5	0.29	0.6	1.08	0.9	0.63	0.8	0.54	0.9
	Total	0.49	0.7	1.11	0.9	0.55	0.7	0.42	0.7
Animals <sup>c</sup>	Year 2	0.81	0.8	1.10	0.8	0.45	0.7	0.52	0.7
	Year 5	0.50	0.8	1.00	0.9	0.42	0.6	0.54	0.9
	Total	0.67	0.8	1.05	0.9	0.44	0.7	0.53	0.8
Artifacts <sup>d</sup>	Year 2	0.61	0.9	1.58	0.7	0.00	0	0.19	0.5
	Year 5	0.58	0.8	1.83	0.5	0.00	0	0.00	0
Total		0.60	0.8	1.69	0.6	0.00	0	0.11	0.4

<sup>a</sup> $M = 2.51$ ,  $SD = 0.7$  (Mean number and standard deviation of codes, including “Other,” assigned to children’s responses about this category). <sup>b</sup> $M = 2.58$ ,  $SD = 0.9$ . <sup>c</sup> $M = 2.71$ ,  $SD = 0.8$ . <sup>d</sup> $M = 2.4$ ,  $SD = 0.7$ .

children's strong orientation to teleo-functional explanation, Teleo-Functional accounts were more frequent than all other forms of explanation in all other categories, all  $t$  tests,  $p < .03$ . In addition, Agency responses exceeded physical explanations for artifacts,  $t(54) = 5.36, p < .001$ , but occurred with equivalent frequency for animals and inanimate natural objects.

Taken together, these results suggest that during elementary school children intuitively identify purpose as the primary explanation for not only artifacts, but also animal and natural object origins, with children also overwhelmingly generating other serving rather than self serving functions for these natural items. In other words, they treated the objects as though they were artifacts. More precisely, among 119 Teleo-Functional answers to open-ended questions about animals and natural objects, only 10 (8%) invoked a self serving function of the form "the first ever monkey existed to swing from trees" or "to have babies." Instead, most took the other serving form that predominates in Appendix B. Nevertheless, although these findings reveal a preference for teleological explanation in children's self-generated origins responses, they also indicate that children are not indiscriminate in their orientation to functional explanations of artifacts and nature: Although children found Teleo-Functional explanations satisfying, they strongly identified physical causes as the primary explanation for why natural events first occurred.

Children's agency responses to open-ended origins questions also were examined to see whether, consistent with a literal artificialism, children trace all causation to human activity. As Table 2 suggests, although children's spontaneous use of ambiguous terms (e.g., he, him, they) meant that the nature of an agent was often indeterminate, when younger and older children generated an "Agency" response, they more frequently mentioned a human agent rather than a supernatural agent as the cause of artifacts. This pattern was also confirmed by  $t$  tests on children's mean responses (Year 2, God vs. person,  $M_s = .09$  [.3] vs. .82 [.9]; Year 5, God vs. person,  $M_s = 0$  [0] vs. 1.0 [.7], both  $t$  tests,  $p < .05$ ). Conversely, when children generated an Agency response to any of the natural items (whether events, living or non-living entities), they were more likely to mention supernatural agents rather than human agents as the cause of nature (Year 2, God vs. person,  $M_s = 1.58$  [1] vs. .29

TABLE 2  
Percentage of Times Children Identified Different Agents When Giving  
Agency Responses to Open-Ended Origins Questions

<i>Who Caused?</i>	<i>Person</i>	<i>God</i>	<i>Nature</i>	<i>Indeterminate</i>
Natural events	19%	50%	8%	23%
Natural objects	19%	44%	0%	37%
Animals	3%	76%	0%	22%
Artifacts	58%	3%	0%	39%

[.6]; Year 5, God vs. person,  $M_s = .88$  [1] vs.  $.24$  [.4], both  $t$  tests,  $p < .05$ ). Such a discrimination echoes the findings of earlier studies based on different methods (e.g., Gelman, 1988; Gelman & Kremer, 1991; Keil, 1989; but see Evans, 2000a; Evans & Mull, 2002) by indicating that, even in their spontaneous answers, young children are not artificialist in the strictest Piagetian sense.

*Closed-ended origins-teleology questions.* A 2 (grade)  $\times$  4 (item type) ANOVA examining children's tendency to endorse teleo-functional explanations when answering closed-ended origins-teleology questions found no effect of grade; a main effect of item type,  $F(3, 159) = 31.78$ ,  $p < .01$ ; and no interactions. The results are presented in Table 3.

The effect of item type occurred because, as with the open-ended origins responses, children endorsed teleo-functional explanations more with artifacts than with nonliving natural objects or animals and endorsed teleo-functional explanation more with all of these categories than with the natural events, all significant  $t$  tests,  $p < .001$ , except natural events vs. animals,  $t(54) = 2.26$ ,  $p < .03$ . Further  $t$  tests against chance indicated that although children had a greater than chance tendency to endorse the other serving teleo-functional answer options when considering artifacts, they actively rejected them for natural events and had no marked preference for this kind of teleo-functional explanation over physical explanation when considering animals and natural objects, significant  $t$  tests,  $p < .001$ . However, this pattern varied within each age group with Year 2 children showing a marginally significant preference for teleo-functional explanations of natural objects that Year 5 children did not share,  $t(30) = 1.99$ ,  $p < .06$ , two-tailed, and Year 5 children showing a marginally significant preference for physical explanation with animals that Year 2 children did not share,  $t(23) = 1.90$ ,  $p < .07$ , two-tailed.

Of interest, these subtle age group tendencies regarding other serving teleo-functional explanations of whole objects are roughly comparable to those found in prior research with 7- and 10-year-old British children when they are pre-

TABLE 3  
Mean Percentage and Standard Deviation of Times Children Endorsed  
Teleo-functional Responses to Closed-Ended Origins-Teleology Questions

Grade	Natural Events		Natural Objects		Animals		Artifacts	
	M	SD	M	SD	M	SD	M	SD
Year 2	32%*	0.6	60% <sup>†</sup>	0.5	53%	0.8	82%*	0.6
Year 5	27%*	0.6	48%	0.7	35% <sup>†</sup>	0.8	92%*	0.5
Total	30%*	0.6	55%	0.6	45%	0.8	86%*	0.6

\* Difference from chance:  $p < .05$ , two-tailed. <sup>†</sup> Difference from chance:  $p < .05$ , one-tailed.

sented with “other serving” teleo-functional explanations of the *properties* of non-living natural objects (Year 2,  $M = 66\%$ ; Year 5,  $M = 53\%$ ) and animals (Year 2,  $M = 47\%$ ; Year 5,  $M = 38\%$ ; Kelemen, 2003). Nevertheless, to investigate whether children’s overall chance responding to the animal and natural objects was due to differential responding to the two items within each item pair—perhaps due to mismatches in the credibility of the teleological explanations presented—an item analysis was conducted. This indicated that for the natural objects items, children had indeed responded differentially to the mountain and the river with children at both grade levels likely to endorse the teleo-functional explanation with the river (71% of children) but the physical explanation with the mountain (62% of children). However, because the teleo-functional explanations in both these items were very similar in content in that both described the function of providing habitat, it seems likely that specific knowledge about mountains, and their relation to volcanoes, was responsible for the disparity of children’s responses in this case.

With respect to the animals, no such differential responding between items was found. The overall chance results for these items occurred because for both the bird and the monkey, roughly half of all children endorsed the teleo-functional explanation (45% of children each item) and roughly half endorsed the physical explanation (55% of children each item). A very likely explanation for this is that the physical explanations for both these items alluded to evolutionary processes and contained ideas that sounded somewhat familiar to many of the children. That is, it seems quite likely that the split result reflects children voting for ideas that they recognized as familiar rather than voting against teleology, especially in the case of the younger children.

*Closed-ended intelligent design questions.* A 2 (grade)  $\times$  4 (item type) ANOVA was conducted on the number of times children endorsed intelligent design explanations. Means are presented in Table 4.

The analysis revealed a marginal effect of grade,  $F(1, 53) = 3.12, p < .08$ , which occurred because, overall, younger children endorsed the notion of an intelligent

TABLE 4  
Mean Percentage and Standard Deviation of Times Children Endorsed  
Intelligent Agency Responses to Intelligent Design Questions

Grade	Natural Events		Natural Objects		Animals		Artifacts	
	M	SD	M	SD	M	SD	M	SD
Year 2	45%	0.9	53%	0.9	73%*	0.8	87%*	0.5
Year 5	35%	0.9	27%*	0.7	58%	0.9	88%*	0.6
Total	41%	0.9	42%	0.9	66%*	0.8	87%*	0.5

\* Difference from chance:  $p < .05$ , two-tailed.

agent ( $M = 65\%$  [2]) more than older children ( $M = 52\%$  [2]). There was also an effect of item type,  $F(3, 159) = 24.61, p < .01$ , which occurred because children were more likely to think that someone caused artifacts than animals and more likely to think that an agent caused both of these items than that someone caused nonliving natural objects or natural events, all  $t$  tests,  $p < .001$ . The orientation to intelligent design was above chance for artifacts and animals although it was younger children's particularly strong tendency to view animals as designed entities that was responsible for the latter effect, both  $t$  tests,  $p < .008$ .

Overall, these results provide support for proposals that children endorse notions of intelligent design in nature (Evans, 2001). Nevertheless, the levels of endorsement provided by British children seem more subdued than those found among Evans's (2001) American participants. Two mutually compatible explanations for this pattern seem possible. One is that aspects of Evans' method (e.g., use of "how" questions, study instructions) made it more effective in eliciting children's ideas about intelligent design. Another is that, given culture-level religiosity differences between Britain and America, British children possess weaker intuitions as to the intelligent design of natural phenomena than Evans' nonfundamentalist Midwestern American children. It is for future research to resolve whether one or both of these explanations is accurate. Finally, the result for natural events also suggests that British elementary-school children's ideas are not overwhelmingly influenced by probable exposure to theologically based narratives about, for example, Noah and the first flood.

As Table 5 indicates when children identified an intentional agent in their responses to intelligent design forced-choice questions, their answers showed a similar pattern to their spontaneous statements when asked open-ended origins questions. That is, among children who specified an identifiable agent, people were seen as the designing agents of the first ever artifacts but a supernatural agent was seen as the cause of the first ever bird, mountain, or storm. This pattern of nonartificialist responding was confirmed at both ages by  $t$  tests on children's mean tendency to endorse supernatural versus human agency with artifacts (Year 2, God vs. person,  $M_s = 17\%$  [.7] vs.  $68\%$  [.8]; Year 5, God vs. person,  $M_s = 5\%$

TABLE 5  
Percentage of Times Children Identified Different Agents When Endorsing  
Agency With Closed-Ended Intelligent Design Questions

<i>Item Type</i>	<i>Human</i>	<i>God, Jesus, Allah</i>	<i>Indeterminate</i>
Natural events	13%	84%	2%
Natural objects	17%	83%	0%
Animals	8%	82%	10%
Artifacts	82%	13%	5%

[.3] vs. 86% [.6]) and natural phenomena (Year 2, God vs. person,  $M_s = 49\%$  [2], vs. 9% [.1]; Year 5, God vs. person,  $M_s = 43\%$  [2] vs. 3% [.4]), all  $t$  tests,  $p < .05$ .

### Summary of Results From Individual Tasks

Analyses of the individual tasks to this point can be summarized as follows: Across age groups, children's clearest intuitions about origins occurred with artifacts and natural events, with both purpose and design seen as highly relevant to explaining artifacts (which children view as humanmade) but somewhat irrelevant to explaining natural events (which children view as having physical-causal antecedents). Children's explanations for animals and nonliving natural objects fall somewhere between these poles but although Year 2 and Year 5 children had an equivalently strong tendency to generate artifact-like teleo-functional ideas when answering open-ended origins questions about animals and natural objects, it was younger children who showed more pronounced teleo-functional and intelligent design intuitions in closed-ended tasks. For example, Year 2 children were more likely to actively endorse teleo-functional over physical causal accounts when explaining natural objects and were more likely to endorse intelligent design rather than non-design when explaining animals.

In the case of Year 5 children, the shift from being likely to generate Teleo-Functional explanations of animals and natural objects in an open-ended task, to then becoming ambivalent or eschewing them in the closed-ended origins-teleology task, potentially reflects children's increasing scientific knowledge base—physical-causal response options probably triggered children's latent knowledge of popular scientific explanations that they have not yet mastered enough to generate for themselves. There is some evidence, then, that older children's reasoning undergoes some form of transition around 9 to 10 years of age as they increasingly retain and elaborate physical-causal explanations that are alternatives to teleo-functional and design explanations of the biological and nonbiological natural world.

Finally, at no age studied was any literal artificialism evident. Neither Year 2 nor Year 5 children seemed inclined to think that natural phenomena were humanmade even though the content of many of their Teleo-Functional explanations did suggest that they thought of natural entities as artifact-like and existing, in many cases, to benefit people.

*Intertask correlations.* A central question of this study nevertheless still remains to be answered. Do children's ideas about the purpose of natural phenomena relate to their ideas about the intelligent design of natural phenomena? Are children who identify natural phenomena as having a purpose, the same children who construe nature as having an intentional designer? As described earlier, the posi-

tion that has been proposed by Kelemen (1999b, 1999d) suggested that an understanding of purpose in nature will be tied up with intuitions about the existence of intelligent design. To explore the connection, children's purpose-based responses to a combined category of all of the natural items in each of the two origins tasks (two animals, two nonliving natural objects, two natural events) were correlated with their intelligent design responses to these same natural items on the final task.

As Table 6 indicates, these analyses provide support for the idea that children's thoughts about purpose in nature are related to their ideas about intelligent design in nature. Specifically, children's intelligent design answers from the final task were significantly correlated both with their teleo-functional responses to closed-ended origins-teleology questions as well as their Teleo-Functional responses to open-ended origins questions. A further indirect reflection of the link between intelligent design and teleo-functional intuitions was also provided by the finding that children's intelligent design answers and their teleo-functional responses in both origins tasks all bore the same relation to open-ended Physical-Reductionist answers from the first task, that is, they were all negatively correlated. As Table 6 also indicates, all of these correlations remained significant even after the effects of age were partialled out, although removal of variance accounted for by age did render the correlation between intelligent design answers and closed-ended origins-teleology answers less robustly significant.

Correlations between intelligent design and purpose responses did not, however, occur in every case: Even though children's Agency responses to open-ended origins

TABLE 6  
Bivariate and Partial (Age) Correlations Between Responses to Open- and Closed-Ended Origins and Intelligent Design Questions About Natural Phenomena (i.e., Animals, Nonliving Natural Objects, and Events).

<i>Measures</i>	<i>Age</i>	<i>Open-Ended Agency</i>	<i>Open-Ended Teleology</i>	<i>Open-Ended Physical</i>	<i>Closed-Ended Teleology</i>	<i>Intelligent Design</i>
Age (continued)	—	-.32*	-.15	.13	-.31*	-.27 <sup>†</sup>
		(—)	(—)	(—)	(—)	(—)
Open-ended agency		—	-.02	-.22	.13	.30*
			(-.07)	(-.19)	(.04)	(.24 <sup>†</sup> )
Open-ended teleology			—	-.75*	.42*	.30*
				(-.74*)	(.39*)	(.27*)
Open-ended physical				—	-.44*	-.32*
					(-.42*)	(-.29*)
Closed-ended teleology					—	.31*
						(.24 <sup>†</sup> )
Intelligent design						—

*Note.* Partial correlation coefficients occur in brackets.

\*  $p < .05$ . <sup>†</sup>  $p < .05$ , one-tailed.

questions seemed to tap children's ideas about intentional design—a conclusion supported by the finding that the Agency and intelligent design scores were correlated—Agency responses did not correlate with children's teleo-functional responses to either closed or open-ended origins questions. Rather than reflecting the absence of a connection between intelligent design and purpose—especially given the existence of other correlations supporting a link—an alternative explanation for the absence of these correlations may be provided by the pragmatics of the open-ended answer context in which the Agency responses occurred. That is, as Table 1 indicates, in general, Agency responses to open-ended questions about any items were rare and this rarity may in part reflect the fact that once speakers self-generated a Teleo-Functional response, they may have presumed that their assumptions about Agency had been implicitly communicated and therefore did not need further explicit elaboration. If this assumption was made, it would have artificially depressed the number of Agency responses, impairing their correlation with other measures because in part their content was subsumed by the open-ended Teleo-Functional response measure, which was the measure most likely to correlate with all others. Tentative support for this idea that the Teleo-Functional responses depressed children's tendency to give open-ended Agency responses is provided by considering children's responses to the artifact items. Specifically, 89% and 84% of children endorsed the teleo-functional explanation of the hat and boat items, respectively. Of these children, 90% (hat) and 83% (boat) also endorsed a closed-ended intelligent design response. This pattern not only suggests that these children know artifacts have purposes and are designed but also that they grasp the association between these facts. Despite this, in these children's spontaneous talk about artifacts in response to open-ended questions, only 18% (hat) and 18% (boat) ever generated an open-ended answer in which both agent and purpose were mentioned (e.g., “made by x for y”). Instead, children's primary response was to give a basic Teleo-Functional response without mention of Agency. This finding was also echoed in pilot work with British undergraduate adults, who despite a presumable grasp of the connection between artifact function and intentional design, almost exclusively gave Teleo-Functional answers with no explicit reference to Agency when responding to open-ended questions about artifact origins (only 4% and 16% of the adults gave answers mentioning both purpose and agent with each of their two artifact items, respectively).

Finally, the correlation between children's endorsement of others' teleo-functional origins explanations and their spontaneous generation of such explanations was explored. As Table 6 indicates, closed- and open-ended teleo-functional responses to questions about natural phenomena were significantly correlated with each other whether the effects of age were partialled out. This supports the idea that when children endorse others' teleo-functional explanations in explanation choice tasks, they are reflecting an explanatory preference that influences their own spontaneous reasoning.

## DISCUSSION

Previous research has found that until approximately 10 years of age, British and American elementary school children have a bias to explain the properties of both living and nonliving natural entities by reference to a purpose (Kelemen, 1999d, 2003). Independently, research has also found that whether they are from Christian fundamentalist or nonfundamentalist backgrounds, American elementary school children have a bias to view living and nonliving natural entities as originally, intentionally created by God (Evans, 2000a, 2000b, 2001). The goal of this study was to draw together and extend these bodies of research by exploring the nature of, and connection between, British elementary school children's intuitions about purpose and design in context of their reasoning about the origins of natural phenomena.

The study generated a number of interesting findings providing support for the conclusion that young British elementary school children are sensitive to both teleo-functional and creationist explanations of nature. To summarize, when asked open-ended questions, British children at both grade levels were most likely to generate Teleo-Functional explanations of artifacts, with a similar but less marked pattern emerging for natural objects and animals that were ascribed artifact-like functions. Although children eschewed teleo-functional explanations for natural events—where children sometimes displayed quite accurate background knowledge—these findings remain consistent with prior research suggesting that children find purpose-based explanation an intuitively satisfying way of making sense of living and nonliving natural entities (Kelemen, 1999c, 1999d, 2003). Especially among younger children, this overall pattern of results carried through to children's responses in the closed-ended origins-teleology task and was echoed again in a final task exploring children's endorsements of intelligent design, in which artifacts and animals were particularly identified as being the products of intentional creation, albeit by different kinds of agents. This latter result is reminiscent of Evans' (2001) finding that, in their considerations of natural entities, children were particularly creationist about living things.

A central aim of this study was, however, to discover whether there is any systematic connection between children's teleo-functional explanations of nature's origins and their intuitions about the nonhuman intelligent design of nature. Consistent with proposals by Kelemen (1999b, 2004), the results from a focused set of correlations suggest that there is and that children who endorse purpose-based explanations of nature also endorse the existence of a creator agent in a manner that may, perhaps, be informed by their understanding of the artifact domain. Children's tendency to endorse teleo-functional explanations was also correlated with their tendency to generate them for themselves, suggesting that forced-choice tasks do not prompt children to teleo-functional explanatory preferences that are not already present.

It could be argued, however, that these correlational results reflect more about children's capacities to engage in online theory building than they do about children's intuitive framework of ideas about nature: That is, having given purpose-based responses in the earlier part of the study, children went on to endorse intelligent designs in the latter section because they suddenly recognized that, together, the ideas were logically consistent. Thus, they effectively constructed something akin to a design stance on nature as they proceeded through the tasks.

However, several considerations make this account somewhat implausible. First, striving for internal theoretical coherence is more a mark of explicit theory building by adult scientists than children (e.g., Gopnik & Wellman, 1994; Harris, 1994) and it is unclear why young children would have any vested interest in ensuring explanatory coherence on so esoteric a topic as first origins. Second, and on a more practical note, none of the children knew when they were responding to the first two tasks that they would later receive questions about intelligent design. This lack of foreknowledge would have made it very difficult for them to monitor their earlier answers such that they could align them with later answers, especially if they lacked a priori intuitions that purpose is connected to intentional design rather than any other kind of physical mechanism (e.g., spontaneous generation, "evolution"). Third, as they progressed through the study, Year 5 children gave subtle indications of engaging in a strategy shift, undermining suggestions that were consistency seeking. Specifically, having been as likely as younger children to produce Teleo-Functional explanations of nature in the first task, older children then went on to become more oriented to endorsing physical explanations in the rest of the study as they heard response options that triggered latent content knowledge. Indeed, these shifts in strategy are potentially one reason why the significant correlations between intelligent design and teleo-functional responses in this study were not even more pronounced.

Putting aside the online theory-building account then, a number of interesting questions nevertheless still remain unanswered. For example, although the findings reveal that children's ideas about design and purpose are related, is this connection robust and does it predate the elementary school years?

With respect to the first question, based on these results, the robustness of the theoretical connection is unclear. Although results revealing a series of significant correlations between the teleo-functional and design intuitions of a relatively small sample of British children might suggest that the link is solid, it is also noted that the Agency measure derived from children's answers to the open-ended origins questions did not correlate with any measures of teleo-functional responding and that other theoretically relevant correlations, although statistically significant, had respectable but not huge effects sizes. As described earlier, one explanation for why Agency did not show much intercorrelation is provided by the pragmatics of linguistic responses to open-ended questions. Respondents might have thought

agency was implicitly communicated by their open-ended teleo-functional response. On the issue of the relative size of the effects, any assessment is really a matter of perspective for, although one view might hold that the correlations seem slightly fragile in light of Kelemen's proposals regarding a connection between function and design intuitions, another view might hold that the effects sizes are actually rather satisfactory in light of the markedly challenging task that was set for children—the task of explicitly articulating a rationale on the abstruse topic of origins for the first time. Resolution of this issue must wait for further research exploring children's intuitions outside the realm of origins explanations.

Turning to the second question, firm conclusions also cannot be drawn on whether the conceptual connection between design and purpose occurs earlier than 6 to 7 years of age. It is entirely feasible that, prior to this age period, children's ideas about design and purpose in nature demonstrate completely independent patterns. However, to the extent that children's understanding of artifacts informs their ascription of purpose and design to nature, there is certainly research indicating that, during the preschool years, children are sensitive to the relation between intended design and purpose in the artifact domain: For example, by around 4 to 5 years of age, children can grasp that an unfamiliar artifact is "for" the activity it was created to perform rather than some other characteristic use (Kelemen, 1999c), they will use an artifact's intended function rather than its characteristic use as the basis for deciding what other objects it belongs with (e.g., when stored in a house; Kelemen, 2004), and will categorize nonfunctioning artifacts into familiar artifact categories by inferring what function the designer intended (Kemler Nelson et al., 2002). Although other studies have not found evidence of this kind of design stance understanding until around 6 to 7 years of age (Defeyter & German, 2003; German & Defeyter, 2000; Matan & Carey, 2000), others point to an even earlier emergence around 3 years of age (Diesendruck et al., 2003; DiYanni & Kelemen, 2003; Kelemen & Carey, 2003, for discussion). In consequence, empirical findings can support the proposal that children have knowledge relevant to a teleo-functional design view of nature as early as the preschool years. Whether children actively use their artifact knowledge as the basis for understanding nature during these early years is a question for further age-appropriate research to discover. However, preschool children's preferential endorsements of statements that living and nonliving natural entities do not just "do things" but are "made for a purpose" are certainly suggestive (Kelemen, 1999c).

To close, the goal of this study was to examine the form of children's spontaneous reflections on questions that would present a challenge to most adults. Children were therefore not asked origins questions with the expectation that they would have considered and established commitments to any answers as truth. Indeed, the questions were posed with the presumption that, prior to the study, children were unlikely to have explicitly pondered answers to most of them despite the fact that, even from early ages, children spontaneously inquire about topics that border on the metaphysical from an adult perspective (Harris, 2002; Kelemen,

Callanan, Casler, & Pérez-Granados, 2003). Instead, what was of interest in this study was whether children would seem orientated to particular kinds of explanation as feasible and satisfying and whether their reasoning, given the novelty of the topic, would show any adult-like coherence or only fragmentary logic. In relation to this, the results not only indicate that children treat teleo-functional and intelligent design explanations of living and nonliving natural entities as particularly viable but that attributions of purpose are related to intuitions about intelligent design. That this is the case among children whose ambient culture is relatively unresponsive to a creationist design stance is also interesting.

How do children's theories develop from this point? To what extent are the kinds of ideas revealed by these findings revised and replaced over development? Answers to these questions are as yet unknown although recent work with a group of Romanian Roma "Gypsies" suggests that when adults (who are not formally religious) are denied the kind of science education that would normally scaffold alternative explanations for natural phenomena, their intuitions remain promiscuously teleological (Casler & Kelemen, 2003). Thus, cognitive immaturity in itself does not seem key to the maintenance of broad teleo-functional ideas. Indeed, one proposal (Kelemen, 1999a, 1999d, 2003) is that such intuitions are a developmental constant, providing the explanatory default or "backdrop" against which alternative explanatory strategies are elaborated over a lifetime. In consequence, children and adults may not be fundamentally different with respect to their ability to entertain promiscuous teleological ideas although it remains for further research to determine the potential veracity of this account.

## ACKNOWLEDGMENTS

This work was supported by Grant NIH HD37903-01 to Deborah Kelemen.

A huge thank you to all the children, teachers, and parents of East Action Primary School and John Perryn Primary School for making this research possible. Many thanks also to Paul Bloom for helpful comments on an earlier manuscript and to Kim Saudino for statistical advice.

## REFERENCES

- Atran, S. (1994). Core domains versus scientific theories: Evidence from systematics and Itza-Maya folk biology. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 316–340). New York: Cambridge University Press.
- 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.
- Baillargeon, R., Spelke, E. S., & Wasserman, S. (1985). Object permanence in five-month olds. *Cognition*, 21, 191–208.

- Barrett, J. L. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, 4, 29–34.
- Bering, J. (2002). The existential theory of mind. *Review of General Psychology*, 6, 3–24.
- Bruce, S. (1999). *Choice and religion: A critique of rational choice theory*. Oxford, England: Oxford University Press.
- Brumby, M. (1985). Misconceptions about the concept of natural selection by medical biology students. *Science Education*, 68, 493–503.
- Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.
- Casler, K., & Kelemen, D. (2003, October). *Teleological explanation and conceptual change: Reasoning about nature among Romanian Roma ("Gypsies")*. Poster session presented at the meeting of the Cognitive Development Society, Park City, UT.
- Defeyter, M., & German, T. (2003). Acquiring an understanding of design: Evidence from children's insight problem-solving. *Cognition*, 89, 133–155.
- De Graaf, D. N., & Need, A. (2000). Losing faith: Is Britain alone? In R. Jowell, J. Curtice, A. Park, K. Thomson, L. Jarvis, C. Bromley, & N. Stratford (Eds.), *British social attitudes: Focusing on diversity. The 17th British social attitudes report* (pp. 119–136). London: Sage.
- Dennett, D. (1990). The interpretation of texts, people and other artifacts. *Philosophy and Phenomenological Research*, 50, 177–194.
- 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.
- DiYanni, C., & Kelemen, D. (2003). How do young children learn about artifacts?: The contribution of physical and intentional cues. *Manuscript submitted for publication*.
- Donovan, E., & Kelemen, D. (2003, April). *Young children's reasoning about natural phenomena*. Poster session presented at the Biennial Meeting of the Society for Research in Child Development, Tampa, FL.
- Evans, E. M. (1994). *God or Darwin? The development of beliefs about the origin of species*. Unpublished doctoral dissertation, University of Michigan.
- Evans, E. M. (2000a). Beyond scopes: Why creationism is here to stay. In K. Rosengren, C. Johnson, & P. 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. (2004). *Magic can happen in that world (but not this one): Constructing a naïve metaphysics*. Manuscript submitted for publication.
- Gelman, S. A. (1988). The development of induction within natural kind and artifact categories. *Cognitive Psychology*, 20, 65–95.
- 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.
- Gelman, S. A., & Markman, E. (1987). Young children's inductions from natural kinds: The role of categories and appearances. *Child Development*, 58, 1532–1541.
- German, T., & Defeyter, M. (2000). Immunity to functional fixedness in young children. *Psychonomic Bulletin and 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.
- Gopnik, A., & Wellman, H. (1994). The theory theory. In L. A. Hirschfeld & S. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 257–293). New York: Cambridge University Press.
- Greene, E. D. (1990). The logic of university students' misunderstanding of natural selection. *Journal of Research in Science Education*, 27, 875–885.

- Guthrie, S. (1993). *Faces in the clouds: A new theory of religion*. New York: Oxford University Press.
- 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. (1994). Thinking by children and scientists: False analogies and neglected similarities. In L. A. Hirschfeld & S. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 294–315). New York: Cambridge University Press.
- Harris, P. (2000). On not falling down to earth: Children's metaphysical questions. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: The development of magical, scientific and religious thinking in contemporary society* (pp. 157–178). Cambridge, England: Cambridge University Press.
- Harris, P. (2002). What do children learn from testimony? In P. Carruthers, S. Stich, & M. Siegal (Eds.), *The cognitive basis of science* (pp. 316–334). New York: Cambridge University Press.
- Johnson, C. N. (2000). Putting different things together: The development of metaphysical thinking. In K. Rosengren, C. Johnson, & P. 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. (2000). Infants' recognition of mentalistic agents. *Trends in Cognitive Sciences*, 4, 22–28.
- 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 (Vol. Eds.), *Minnesota symposia on child psychology: Vol. 25. Modularity and constraints in language and cognition* (pp. 103–137). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Keil, F. C. (1994). Explanation, association, and the acquisition of word meaning. *Lingua*, 92, 169–198.
- Keil, F. C. (1995). The growth of causal understandings of natural kinds. In D. Sperber, D. Premack, & A. J. Premack (Eds.), *Causal cognition: A multi-disciplinary debate* (pp. 234–262). Oxford, England: Clarendon.
- 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). Functions, goals and intentions: Children's teleological reasoning about objects. *Trends in Cognitive Sciences*, 12, 461–468.
- Kelemen, D. (1999c). The scope of teleological thinking in preschool children. *Cognition*, 70, 241–272.
- Kelemen, D. (1999d). Why are rocks pointy? Children's preference for teleological explanations of the natural world. *Developmental Psychology*, 35, 1440–1453.
- Kelemen, D. (2003). British and American children's preferences for teleo-functional explanations of the natural world. *Cognition*, 8, 201–221.
- Kelemen, D. (2004). Are children "intuitive theists"? Reasoning about purpose and design in nature. *Psychological Science*, 15, 295–301.
- Kelemen, D., & Carey, S. (in press). The essence of artifacts: Developing the design stance. Chapter to appear in S. Laurence & E. Margolis (Eds.), *Creations of the mind: Theories of artifacts and their representation*. Oxford, England: Oxford University Press.
- Kelemen, D., Callanan, M., Casler, K., & Pérez-Granados, D. (in press). "Why things happen": Teleological explanation in parent-child conversations. Manuscript submitted for publication.
- Kelley, J., & De Graaf, N. D. (1997). National context, parental socialization and religious belief: Results from 15 nations. *American Sociological Review*, 62, 639–659.
- Kemler Nelson, D., Herron, L., & Morris, C. (2002). How children and adults name broken objects: Inferences and reasoning about design intentions in the categorization of artifacts. *Journal of Cognition and Development*, 3, 279–194.
- Kerner, R. (2003, April). *Promiscuous Teleology and children's preferences for different types of teleological explanations*. Poster session presented at the Biennial Meeting of the Society for Research in Child Development, Tampa, FL.

- Leslie, A. (1982). The perception of causality in infants. *Perception, 11*, 173–186.
- Massey, C., & Gelman, R. (1988). Preschoolers decide whether pictured unfamiliar objects can move themselves. *Developmental Psychology, 24*, 307–317.
- Matan, A., & Carey, S. (2000). Developmental changes within the core of artifact concepts. *Cognition, 78*, 1–26.
- 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.
- Samarapungavan, A., & Weirs, R. W. (1997). Children's thoughts on the origin of species: A study of explanatory coherence. *Cognitive Science, 21*, 147–177.
- Shultz, T. (1982). Rules of causal attribution. *Monographs of the Society for Research in Child Development, 47*(1, Serial No. 194).
- Spelke, E. S. (1991). Physical knowledge in infancy: Reflections on Piaget's theory. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition* (pp. 133–169). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.
- Verweij, J., Ester, P., & Nauta, R. (1997). Secularization as an economic and cultural phenomenon: A cross-national analysis. *Journal of the Scientific Study of Religion, 36*, 309–324.
- Woodward, A. (1998). Infants selectively encode the goal of an actors reach. *Cognition, 69*, 1–34.

## APPENDIX A

### Answers to Closed-ended Origins-Teleology Questions

#### *Natural Events*

Why did the first ever thunderstorm occur?

- P) The first ever thunderstorm occurred because cold and warm air all rubbed together in the clouds.
- T) The first ever thunderstorm occurred to give the earth water so everything would grow.

Why did the first ever flood occur?

- P) The first ever flood occurred because it rained so much that water covered everything.
- T) The first ever flood occurred to wash and clean the earth of bad things.

#### *Nonliving natural objects*

Why did the first ever river exist?

- P) The first ever river existed because big blocks of ice melted and made lots of water.

T) The first ever river existed to provide fish and crocodiles with somewhere to live.

Why did the first ever mountain exist?

P) The first ever mountain existed because a volcano erupted and cooled into a big lump.

T) The first ever mountain existed to give animals a home and somewhere to go climbing.

### *Animals*

Why did the first ever monkey exist?

P) The first ever monkey existed because some animals developed into people and some developed more like this.

T) The first ever monkey existed to give trees a swinging animal and tigers something to eat.

Why did the first ever bird exist?

P) The first ever bird existed because an animal that lived on the ground began to develop wings and fly.

T) The first ever bird existed to eat worms and insects so there wouldn't be too many of them.

### *Artifacts*

Why did the first ever boat exist?

P) The first ever boat existed because bits of wood got fixed together.

T) The first ever boat existed to carry people over water.

Why did the first ever hat exist?

P) The first ever hat existed because material got formed into a round shape.

T) The first ever hat existed to keep someone's head warm.

## APPENDIX B

Samples of Children's Open-Ended Origins Responses to  
"Why did the first ever X exist or occur?"*Agency*

Bird: "God invented birds."

Monkey: "God made it and put it, like, to life and it ... lived in the jungle."

River: "because probably people always put water in a big hole."

Boat: "I think the people builded it."

Hat: "'cos probably someone knitted it."

*Teleo-Functional (with or without Agency)*

Bird: "to make nice music." (Tel.)

Bird: "because it make the world look nice" (Tel.)

Bird: "because ... they needed more nature in the country because it probably was dirty in the olden days so they invented ... invented birds come up." (Agency + Tel.)

Monkey: "Allah ... he makes everything..he brings everyone ... and he brings monkeys so they can have babies." (Agency + Tel.)

Monkey: "so then we had somebody to climb trees." (Tel.)

Monkey: "so there can be an animal in the jungle." (Tel.)

Monkey: "same as for all creatures ... 'cos they were put on this earth for their life for nature, for looking at for interest and these sorts of things." (Agency + Tel.)

Monkey: "because God gave it life to make people" (Agency + Tel.)

Monkey: "... the manager of the zoo-place wanted some ... um ... monkeys and there wasn't none so God had to create it and it was a long time for to create." (Tel.+ Agency)

Mountain: "because people could climb it and see how dangerous it could be sometimes." (Tel.)

Mountain: "they made mountains ... so people can look at them they maybe can get a piece of paper and draw." (Agency + Tel.)

Mountains: "'cos the earth, perhaps, there were usually always—all the time—earthquakes and they needed something to ... like a paperweight ... like perhaps there was lots of earthquakes so they thought that there should be something that could stop them so they put lots and lots of weights of stone." (Agency + Tel.)

River: "so boats could come in the water." (Tel.)

River: "so that people could do fishing." (Tel.)

Flood: "I don't know ... to punish bad people." (Tel.)

Flood: "because God ... 'cause the land was dry and God wanted it to be a bit wet." (Agency + Tel.)

Boat: “because Moses built one to make all the animals and all the people get in one so they can’t be drowned by the flood.” (Agency + Tel.)

Boat: “‘cos people wouldn’t have to swim in rivers ‘cos there might be sharks or something.” (Tel.)

Hat: “when it started up cold they invented hats for them to wear on their heads.” (Agency + Tel.)

Hat: “because people that wants to sell it or people who wants it for the baby ... people that makes this hat knits it.” (Tel + Agency)

### *Physical-Reductionist*

Bird: “because animals evolved and they went inland and they went into trees and a bird appeared.”

Monkey: “probably another transformation of some kind of dinosaur.”

Monkey: “it came from the mummy’s stomach.”

Mountain: “I just think it was basically uneven ground building up until, like, it just came to a rest and people just called them mountains and called them names and started climbing up them.”

Mountain: “because I think it used to be a volcano and it just closed up.”

Mountain: “I think the snow keeps falling down so it made it.”

River: “because when it rained there was a big hole in the ground, and then there was water.”

Storm: “two clouds bashed together.”

Flood: “because there was rain ... lots of rain and it didn’t stop.”

Flood: “because it rains every day ... and ... um ... then it gets fuller and fuller.”