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British and American children's preferences for teleo-functional explanations of the natural world

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Abstract

Teleological-functional explanations account for objects by reference to their purpose. They are a fundamental aspect of adults' explanatory repertoire. They also play a significant role in children's reasoning although prior findings indicate that, in contrast to adults, young children broadly extend teleological explanation beyond artifacts (e.g. chairs) and biological properties (e.g. eyes) to the properties of non-living natural phenomena (e.g. clouds, rocks). The present study extends earlier work with American children to explore British children's application of teleological explanation. The motivation is that while Britain and America are, culturally, as close to a minimal pair as the global context affords, there are differences in the religiosity of the two nations such that British children might be less inclined to endorse purpose-based explanation. Results reveal that young British children also possess a promiscuous teleology although they differ in the kinds of purposes that they attribute. Additional findings include a replication of earlier effects using a modified task with young American children.

Keywords: Children; Intuitive theories; Function; Biology; Artifacts

1. Introduction

Teleological-functional explanations ("teleological explanations" for short) assume that objects or events occur for a purpose. Such explanations are a significant feature of adults' cognition not only guiding their reasoning about intentionally designed artifacts but also living things. For example, adults view objects like ears as existing for hearing much as they view objects like brooms as existing for sweeping. By default, they also tend to presume that animal behaviors serve some biological purpose even if that function is as yet undiscovered.

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Because teleological explanation has such a central role in constraining adults' construal of biological entities, it has been of increasing interest to those concerned with the development of children's intuitive theories of the natural world (e.g. Carey, 1995; Hatano & Inagaki, 1999; Keil, 1992, 1995; Kelemen, 1999a; Kelemen, Widdowson, Posner, Brown, & Casler, in press). A major reason for this is that in the context of Western adults' reasoning about natural phenomena, teleological explanation performs an important function: it delineates conceptions about living things from those of non-living natural objects. For example, as a biological entity, an orifice such as a nostril is assumed to be *for* something (e.g. breathing, smelling) with its function providing a raison d'être in the sense that it provides a sufficient explanation for why the structure even exists. In contrast, a non-biological natural entity – an orifice such as a cave – is likely to be viewed as purposeless despite the fact that it also has certain uses and activities (e.g. provides a home for bats, produces stalagmites, protects an underground water source). In the case of the non-living natural entity, however, such activities are seen as side-effects of the physical–mechanical forces that caused the object to form rather than a functional explanation for why it formed. This tendency to carve up the biological and non-biological natural world along teleological joints has been assumed by some scholars to reflect an innate association between biology and teleology, and, perhaps, to indicate that teleology is the basis of an innate, universal, theory of biology (Atran, 1994, 1995; Keil, 1992, 1995; see also Opfer & Gelman, 2001). Given these claims, a question motivating prior research has therefore been whether children share adults' selective teleological intuitions (Keil, 1992, 1995; Kelemen, 1999a,b). Two main views have emerged in the context of this debate.

One view can be labeled Selective Teleology (ST), and follows from proposals by Keil (1992, 1995) that teleological intuitions about biological function are the basis to a rudimentary but essentially adult-like innate theory of biology. Specifically, Keil suggests that from early on, children, like adults, differentiate biological from non-biological natural entities by viewing the properties of the former, but not the latter, as designed for a purpose. He also proposes that young children have an adult-like sensitivity to the kinds of functions implied by different domains. For example, young children recognize that while biological functions produce "self-serving" survival effects for the organisms that possess them, artifact functions perform "other-serving" activities that benefit external agents.

Several findings provide support for the ST proposal. Specifically, Keil provides suggestive evidence that from 3 years of age, children will functionally distinguish an artifact from a living thing by identifying a biological part (e.g. a barb on a rose) as "self-serving", but a parallel part on an artifact (e.g. a barb on barbed wire) as "other-serving" (unpublished data; Keil, 1995). In other research, Springer and Keil (1989) found that preschoolers seem to possess a biology-specific sensitivity to the self-serving, physiological, nature of biological functions: when asked to make inheritance judgments, they are more likely to judge an abnormal trait (e.g. a white stomach) as heritable when it has the "biological functional" consequence of helping an animal "to stay healthy" than when it has the "social functional" consequence of "helping it stay happy". Finally – and most relevant to the issue of whether children are selectively teleological about nature – Keil (1992) (also Keil, 1995) conducted a study in which children were presented with either a

living thing (e.g. a plant) or a non-living natural kind (e.g. an emerald). They were then asked to choose between a teleological explanation and a physical explanation for one of the object's properties (e.g. greenness). Keil found that second grade children were more likely to choose the teleological explanation with the living thing (e.g. "it's green because it helps there be more of them") but the physical explanation with the non-living thing (e.g. "it's green because tiny parts mix together to give them a green color") (Keil, 1992). Taken together, these results are suggestive of a selective teleological construal. However, the studies have been subject to various methodological criticisms (see Carey, 1995; Kelemen, 1999a; Solomon, Johnson, Zaitchik, & Carey, 1996) with the last result, in particular, proving difficult to interpret due to an experimental confound. Specifically, the teleological statements employed phrases that were not only teleological but also contained words characteristically reserved for animates, making it unclear whether animacy or teleology motivated children's tendency to associate the statements with living things (for further details see Kelemen, 1999a; Matan & Carey, 2001).

An alternative view to ST is Promiscuous Teleology (PT), and is prompted by Kelemen's proposals that the tendency to construe entities as "designed for a purpose" results from a default bias to plug explanatory gaps by treating objects as though they are intentionally-created artifacts – a bias that is itself argued to derive from a human predisposition to engage in intentional reasoning (Kelemen, 1999c,d; see also Piaget, 1929; see Gergely, Nádasdy, Csibra, & Bíró, 1995; Johnson, 2000; Woodward, 1998, for infant intentionality research). PT predicts that in the absence of physical–mechanical knowledge, scientifically naive children will default to an artifact model and, unlike contemporary Western-educated adults, explain the properties of both living and non-living natural kinds in terms of a purpose. PT makes no prediction as to the specifics of children's teleological intuitions since both self-serving and other-serving functions are evident in the artifact domain (i.e. bicycles may exist for others to ride on, but the pedals exist to move the bicycle itself).[1]

Several findings provide support for the PT proposal. For example, in one study, preschool children and adults were asked what living things, artifacts, non-living natural objects and their properties were "for", while explicitly being given the option of saying they were not "for" anything. Children differed from adults' selectivity by assigning a function for almost every kind of object and object part (Kelemen, 1999a). Preschool children were again found to contrast with adults in a follow-up forced-choice task in which they broadly endorsed the notion that objects of all kinds are "made for something" (Kelemen, 1999a). A further study was then conducted to explore how children's teleological intuitions develop during the elementary school years (Kelemen, 1999b). In the study, 7-, 8-, and 10-year-old children were asked, as in Keil (1992), to choose between a teleological and a physical explanation of properties of various unfamiliar living and non-living natural entities. However, in contrast to Keil's method, the teleological explanations employed neutral language and varied in nature: some described "self-serving" functions

[1] The proposal that children view objects as quasi-artifacts is not akin to Piaget's proposal that children entirely conflate the natural and artifact domains. There is ample evidence that children discriminate natural kinds and artifacts on the basis of perceptual features (e.g. Massey & Gelman, 1988), knowledge of human artifact origins (e.g. Gelman & Kremer, 1991; Keil, 1989), and intuitions about natural essence (e.g. Gelman, 1988).

that were quasi-biological in having effects that contributed to the continued "well-being" of the object itself (e.g. "the rocks were pointy so that animals wouldn't sit on them and smash them") and some described "social" functions that were more interpersonal and artifact-like in having effects benefiting external agents (e.g. "the rocks were pointy so that animals could scratch on them when they got itchy"). While adults selectively endorsed only physical explanations with non-living natural entities (e.g. "the rocks were pointy because bits of stuff piled up for a long time") and self-serving teleological explanations with living things (e.g. "Cryptoclidus had long necks so that they could move easily through the water"), younger children preferred teleological explanations (of any kind) over physical explanations for the properties of both living and non-living natural kinds. Ten-year-olds – the group with most exposure to formal science – were the only set of children to provide more adult-like responses. These general "promiscuity effects" were particularly noteworthy because they echoed findings of an earlier study (Study 1, Kelemen, 1999b), despite the fact that, in contrast to that study, participants received a pretrial tutorial which provided cues as to the way physical explanation applies to a non-living natural kind (a cloud) (Study 2, Kelemen, 1999b).

Based on these results then, there is considerable evidence that young children possess a promiscuous teleological bias that only becomes more selective as children accrue some degree of scientific education. Given the proposal that this tendency originates because of a predisposition to intentional reasoning, the corollary assumption is that young children's "promiscuous teleology" is universal. However, a challenge to this assumption of universality can be made for the following reason: to date, while all of these studies of teleological reasoning have employed various samples from various geographical regions, they have been conducted in only one country: the United States. In the interest of expanding beyond this limit (see Coley, 2000), the present paper extends the exploration of teleological thought to children from another culture, Britain, which shares many features with American culture but also differs in ways that are potentially relevant to the development of teleological reasoning. But what are the relevant similarities and differences?

The similarities are manifold and, to a large extent, obvious. Historical relatives, Britain and America are both industrialized, technologically advanced, literate, democratic nations with a highly developed national media, compulsory education and many comparable traditions, institutions, and social structures. Significantly, for an investigation of teleological reasoning, they share a common, majority language and use the same linguistic conventions to express teleological ideas. In terms of conducting a cross-cultural comparison then, the dimensions of cultural difference that might promote spurious comparative effects are far more limited between America and Britain than between America and other more exotic cultures since, in many respects, the two countries are as close to a "minimal pair" as the global context affords. However, there is one particularly interesting difference between Britain and America that is potentially relevant to the development of children's teleological ideas: the difference in cultural religiosity.[2]

[2] Note that this difference between Britain and America is one that might not necessarily be as marked between America and other more distant cultures given America's status as a religious "exception" in context of similar, Western, industrialized nations (see next section). This is part of the rationale for conducting a less exotic, cultural comparison.

The religious belief in a divine designer is an inherently teleological notion. It is also a notion that has been more consistently endorsed in the United States than in any other modern, industrialized nation – a phenomenon which sociologists refer to as American religious "exceptionalism" and regard as an enduring, if not defining, feature of American culture (e.g. De Graaf & Need, 2000; Demerath, 1998; Kosmin & Lachman, 1993; Lipset, 1996; Madsen, 1998; Marty, 1987; Reichley, 1985; Verweij, Ester, & Nauta, 1997; Warner, 1993). Various surveys provide a sense of the patterns characterizing this exceptionalism. For example, it is found that 85% of Americans self-identify as somewhat religious (University of Chicago National Opinion Research Center (NORC); Smith, 1998), approximately 94% believe in God (Harris Organization, 2000), 82% believe that humans originated through a form of divine intervention (Gallup Organization, 2001), and 48% attend religious services at least once a month (NORC, 2001). Statistics of this kind, based on random sampling across various locales, have stayed relatively constant over intermittent polls for at least the last 20 years. As to the source of this religious exceptionalism, sociologists often trace it to what is known as America's "civil religion": a unifying conviction, dating from colonial times, which characterizes America as "God's country", entrusted with a divine mission of fostering progress and preserving freedom (e.g. Madsen, 1998; Marty, 1987; Wilson, 1979). Whether or not this is the primary source of the religiosity, this conviction certainly continues to have popular appeal, leading to a diffusion of religious messages in political rhetoric and social ritual (a.k.a. "God-talk"; Carter, 2000; Tickle, 1997), reflecting a form of non-denominational theism that is part of the cultural identity of many Americans and, as such, is tolerated as a part of general cultural discourse (Edwords, 1987; Lippy, 1994; Reichley, 1985; Wilson, 1979).

By contrast, no comparable kind of civil religion currently exists in Britain, and while America continues to maintain a top ranking position on indices of religiosity, statistics from the most recent British Attitudes Survey (BAS) prompted the summarizing authors to conclude that Britain now has one of the least religious populations in the world (De Graaf & Need, 2000; for similar conclusions see also Kelley & De Graaf, 1997; Verweij et al., 1997). The following gives a general sense of the difference. While 80% and 63% of American NORC General Social Survey respondents agree, respectively, that they have always believed in God and know without doubt "that God really exists" (Davis & Smith, 1991; Smith, 1998), the same is true of only 48% and 21% of BAS respondents (De Graaf & Need, 2000). While 79% of American adults in their prime child-rearing years (18- to 34-year-olds) self-identify as having religious convictions (NORC, 2001) the same is true of only 25% of Britons who are more likely (42%) to actively label themselves as non-religious (reported in Bruce, 1999). Finally, while 48% of Americans say they attend a religious service at least once monthly (NORC, 2001), this is true of only 20% of British people (De Graaf & Need, 2000), with membership in the Church of England dwindling at around 10% (Bruce, 1999).

Such figures capture general differences in cultural attitudes and norms, but what makes them more relevant in relation to investigations of teleological beliefs are recent findings that cultural differences in the religiosity of British and American adults cause general differences in their tendency to broadly invoke teleological explanation. Specifically, as described earlier, American college-educated adults generate scientifically-appropriate

patterns of selective teleological beliefs in the "quiz-like" context of explicit experiments. However, recent research finds that when their intuitions are probed in a less formal and evaluative context in which they are simply asked to write responses to open-ended questions (e.g. "Why do monkeys exist?" "Why do thunderstorms occur?"), American college-educated adults become far more likely to generate teleological explanations of living and non-living natural phenomena and almost twice as likely to do so than British college-educated adults (animals: 53% vs. 27%; non-living natural phenomena: 23% vs. 12%). Importantly, this difference between groups (both groups consisted of individuals from a college town environment) is positively predicted by independently assessed self-ratings of religiosity, with the American college adults self-rating a mean level of religiosity more than twice that of the British college adults (57% vs. 24%) (Kelemen, 2003).

When considered with the sociological data, this pattern of adult results raises an interesting possibility. Perhaps the finding of a promiscuous teleological endorsement in American children is idiosyncratic – an effect of socialization that reveals more about American children's ability to adopt culturally available and authorized patterns of explanation (see Sperber, 1996) than either their intuitive biases or their own personal religious convictions.[3] This possibility is explored in the present study with British children which puts reliance on teleological explanation to the test using the Study 2 method of Kelemen (1999b) which incorporated a pretrial tutorial on physical explanation. Specifically, the current study addresses the following question: as a consequence of their culture, do British and American elementary school children differ in their preference for teleological-functional explanations of the natural world?

2. Study 1

2.1. Method

2.1.1. Participants

The participants were 48 children attending Years 2, 3, and 5 of two state-funded, ethnically diverse British primary schools drawing from urban, blue collar communities in West London. There were 16 7-year-old children in Year 2 (5 males and 11 females; mean age: 7 years 3 months; SD = 4 months), 16 8-year-old children in Year 3 (7 males and 9 females; mean age: 8 years 4 months; SD = 3 months), and 16 10-year-old children in Year 5 (8 males and 8 females; mean age: 10 years 1 month; SD = 4 months). The American data for comparison came from the existing data set of Study 2 of Kelemen (1999b) consisting of 16 7-year-old children (9 males and 7 females; mean age: 7 years 1

[3] This possibility only makes sense if it is accepted that children's behavior can be influenced – often in spite of parents' attitudes – by cultural representations delivered via authorities such as schools, the peer group, and the media. Such representations and authorities are already assumed by many scholars to be a primary influence on other aspects of child development (e.g. gender attitudes and behavior; see Harris, 1998). It should also be noted that the possibility raised here is not that promiscuous teleological responding results because, through simple exposure to cultural religiosity, children have developed religious convictions or teleological beliefs. It is the subtler suggestion that when children feel compelled to give intuitions, their responses may be influenced by the relative availability of culturally sanctioned religious/teleological ideas.

month; SD = 4 months), 16 8-year-old children (9 males and 7 females; mean age: 8 years 2 months; SD = 6 months), 16 10-year-old children (3 males and 13 females; mean age: 10 years 2 months; SD = 7 months), and 16 adult university undergraduates. The children represented a low socio-economic status (SES), diverse minority population attending Grades 1, 2, and 4, respectively, of an urban elementary school in Oakland, CA. There were no significant age differences between the current sample of British children and the original sample of American children. Among the American children, second and fourth grade children had received exposure to some science curriculum. Consistent with the English National Curriculum, all of the British children had been exposed to some science curriculum.

2.1.2. Materials

The materials were the same as those in Study 2 of Kelemen (1999b). Each child saw four pairs of realistic, hand-drawn, color pictures, each pair consisting of an unfamiliar prehistoric animal and an unfamiliar, prehistoric, non-living natural object. Set One consisted of an aquatic reptile ("Cryptoclidus") and a pointy rock. Set Two consisted of a large mammal ("Macreuchenia") and a still pond. Set Three was a terrestrial bird ("Mononykus") and a grainy sand dune. Set Four was a small mammal ("Moeritherium'') and a green stone. In addition to these picture pairs, there was a set of three photographs that were used in the pretrial tutorial on cloud formation and showed three different examples of clouds: a big fluffy cloud, a thin wispy cloud, and a long smooth cloud. There was also a separate card with a sequence of three hand-drawings depicting the stages in the formation of a cloud.

2.1.3. Design and procedure

The design and procedure of this study were the same as Study 2 of Kelemen (1999b). Children were interviewed individually by an experimenter in a quiet room at their school and completed the task in 15–20 minutes. Before beginning the short pretrial session, participants were told that they were first going to look at some pictures of clouds and talk about them and that later they would see some other pictures and get to talk about those as well. Participants then engaged in a pretrial tutorial session in which the experimenter showed them drawings of three different kinds of clouds and explained "how scientists think clouds form and why they think they are in the sky". The description of cloud formation was then given in very simple non-teleological language and a sequence of pictures depicting the explanation was shown simultaneously. The pretrial culminated in the presentation of a final picture showing water droplets aggregated into a cloud. It was accompanied by the words "scientists think that when there are lots of tiny drops in the same place then they collect together and when that happens they make a cloud high up in the sky…Cool! So now you know how scientists think clouds form and why they are up in the sky. They are all made up of tiny drops of water and sometimes when the water drops get really cold then it rains. Now, here's what I want you to do. I want you to try and think like a scientist about some things."

Participants then moved on to the main part of the study. They were told that they were going to be asked some questions about things from a long time ago and that the experimenter would suggest some possible answers to the questions. Each child was asked to try

to think like a real scientist and pick the answer that made most sense to them. They were then presented with each of the four animal–natural object picture sets in random order. For each picture set, participants were shown the picture of the animal and told its name, for example, "Here is a Cryptoclidus". They were also shown the picture of the non-living natural object, for example, a pointy rock, and told that it was of a kind that was found where the animal lived. Participants were then asked three questions, in random order, about the objects. Specifically, they were asked a question about a biological property of the animal that had also been asked in Studies 1 and 2 of Kelemen (1999b) (e.g. "Why do you think Cryptoclidus had such long necks?"), a question about a biological property that was specific to Study 2 of Kelemen (1999b) (e.g. "Why do you think Cryptoclidus had such smooth skin?") and a question about a property of a non-living natural kind that was again common to both Studies 1 and 2 of Kelemen (1999b) (e.g. "Why do you think the rocks were so pointy?")[4].

As each question was asked, the relevant feature was pointed out on the animal or natural kind picture. Immediately after each question, the experimenter offered two possible answers. One answer presented a physical-reductionist explanation while the other answer involved a teleological explanation, although its nature varied across picture sets. In two of the four picture sets, the teleological answers to all three questions described quasi-biological "self-serving" functions. In the other two picture sets all teleological explanations involved other-directed, more artifact-like "social" functions. The pairings between physical and teleological explanations were counterbalanced so that half the participants heard "self-serving" teleological answers with Picture Sets One and Two and the other participants heard "social" teleological explanations. As a consequence, when asked why a kind of sand was so rough and grainy, participants in both counterbalancing sets heard the physical explanation "it was grainy because bits of shells got broken and mixed up making it that way" but only half the participants heard this paired with the "self-serving" teleological explanation "it was grainy so that it wouldn't get blown away and scattered by the wind". The other half of the participants heard the "social" teleological explanation "it was grainy so that animals like Mononykus could easily bury their eggs in it". After participants had indicated which of the two explanations "made most sense", they proceeded to the next question or the next picture set. The items are presented in Appendix A.

Within each counterbalancing group, half the participants received Set One or Two first and the other half saw Set Three or Four first. As with picture and question presentation, the order in which the physical vs. teleological explanations were presented was randomized. However, to keep the procedure for testing American and British children as similar as possible, the random order presented to each British child exactly matched one that had been received by an American child within the same age group in Kelemen (1999b).

[4] In Kelemen (1999b) the addition of a second biological property question in Study 2 was prompted by concerns about the social teleological explanations of Study 1 biological property trials that eventually proved to be unfounded (for discussion see Kelemen, 1999b, pp. 1446–1447). In the interests of consistency, however, as both trials had been presented to American participants, they were also presented to British participants.

2.2. Results

To allow comparisons between the British and American data sets, the present study adopted exactly the same method and design as Study 2 in Kelemen (1999b). In the original version, American children were presented with two kinds of trials probing explanatory intuitions about biological properties (see Footnote 4). One set of trials was the same as that used in Study 1 of Kelemen (1999b) and employed social teleological explanations that were other-serving in nature but occasionally also anthropomorphic. The other set of Study 2 trials described social teleological explanations that were purely other-serving in nature. In Kelemen (1999b), preliminary analyses compared responses to the two sets of trials to examine the influence of anthropomorphism on younger children's bias to endorse social teleological explanations of biological properties. The analyses found no meaningful differences in American children's responses to the two kinds of trials and, for simplicity, responses were collapsed together in further analyses. In the present study, a similar preliminary 2 (trial type) × 2 (function type) ANOVA was conducted. It found no effects of trial type or interactions so, as in Kelemen (1999b), British children's responses were collapsed into one biological property variable in remaining analyses.

To restate, the main issue of interest in the current study was whether young British and American children share a tendency to promiscuously endorse teleological explanations of both living and non-living natural kind properties or whether British children display more adult-like intuitions, eschewing any kind of teleological explanation of the natural world and endorsing only self-serving teleological explanations of biological properties.

To address this question, a 3 (age: 7-, 8-, and 10-year-olds) × 2 (country: USA vs. UK) × 2 (property type: biological vs. non-living natural kind) × 2 (function type: self-serving vs. social) mixed ANOVA was performed comparing British and US children's tendency to endorse teleological explanations with different types of natural objects. To control for the different number of trials for each property type, proportion scores were used in analyses. Table 1 presents the mean percentage of times that British and American children endorsed teleological explanations with each property type.

The analysis found main effects of age ($F(2,90) = 4.75$, $P < 0.01$) and function type ($F(1,90) = 20.71$, $P < 0.01$). It also revealed a series of significant two-way interactions: an Age × Country interaction ($F(2,60) = 3.91$, $P < 0.05$), an Age × Function Type interaction ($F(2,90) = 4.21$, $P < 0.05$), and a Property Type × Function Type interaction ($F(1,90) = 30.17$, $P < 0.05$). Finally, it revealed a marginal four-way Age × Country × Property Type × Function Type interaction ($F(2,90) = 2.55$, $P < 0.08$). Since the four-way interaction subsumed all of the two-way interactions, it was examined further in two separate 3 (age) × 2 (country) × 2 (function type) mixed ANOVAs on British and American children's teleological responses to the biological and non-living natural object trials, respectively. Main effects are reported below when theoretically relevant or when not embodied in an interaction. Post hoc tests were conducted using Fisher's Least Significance test and one-group *t*-tests against chance.

The ANOVA on the biological properties revealed a series of significant two-way interactions: Age × Country ($F(2,90) = 4.13$, $P < 0.05$), Age × Function Type ($F(2,90) = 8.07$, $P < 0.05$), and Country × Function Type ($F(1,90) = 6.73$, $P < 0.05$). However, these were subsumed by a three-way Age × Country × Function Type interac-

Table 1
Mean percentage of trials in which teleological explanations were endorsed by British and American participants

		Biological properties		Non-living natural kind properties	
		Self-serving	Social	Self-serving	Social
UK	7-year-olds	69*	47	53	66
	8-year-olds	80*	33*	63^{-}	63^{-}
	10-year-olds	81*	38^{+}	59	53
USA[a]	7-year-olds	77*	75*	66^{+}	69*
	8-year-olds	72*	61	75*	69*
	10-year-olds	75*	28*	41	47
	Adults	67^{+}	19*	9*	13*
USA Study 2	7- and 8-year-olds	75*	61^{+}	74*	70*

[a] US data reprinted from Kelemen (1999b). Notations indicate preferences differing from chance. $^{*}P < 0.05$, two-tailed; $^{+}P < 0.05$, one-tailed; $^{-}P = 0.05$, one-tailed.

tion ($F(2, 90) = 2.76$, $P < 0.07$). Further analysis of this interaction revealed that it occurred because, while British and American children shared an equivalently strong preference for self-serving teleological explanations of biological properties (*t*-tests, $P < 0.05$), they differed in their view of social teleological explanations. American 7- and 8-year-old children were significantly more likely than their British counterparts to endorse explanations that explained animal properties in terms of their social "other-serving" abilities. They were therefore more likely to accept the possibility that the reason why an animal has a big body is so that it can shelter smaller animals. British children went from ambivalence about such ideas at 7 years of age to actively rejecting them in favor of physical explanations from 8 years of age onwards. By 10 years of age, British and American children did not differ and had an equivalent adult-like tendency to endorse physical over social teleological explanations (*t*-tests, $P < 0.05$).

With regard to the natural objects, the ANOVA revealed an effect of age ($F(2, 90) = 3.63$, $P < 0.03$), but there was no effect of country or function type and no interactions. The age effect occurred because, in general, 8-year-old children were significantly more likely to adopt purpose-based explanations of objects like rocks and ponds than 10-year-old children (7-year-olds, $M = 63\%$; 8-year-olds, $M = 67\%$; 10-year-olds, $M = 50\%$). As noted, there were no effects of country and, overall, British children, like American children, had a preference for teleological rather than physical explanations of natural object properties (US children, $M = 61\%$; UK children, $M = 59\%$; both *t*-tests, $P < 0.05$). However, in contrast to American 7- and 8-year-olds who had above chance preferences for both self-serving and social teleological explanations of non-living natural kind properties, British 7- and 8-year-old children's teleological preferences tended to approach significance but not reach criterion, a result that might suggest some ambivalence to functional accounts of this domain.

In the interest of thoroughness, further analysis was conducted to see how similar British children's responses were to the selectively teleological responses of the American

Table 2
Numbers of participants endorsing teleological explanations of non-living natural kind properties

		Never	One	Two	Three	Four
UK	7-year-olds	2	1	4	7	2
	8-year-olds	0	2	5	8	1
	10-year-olds	1	4	3	6	2
USA[a]	7-year-olds	0	3	3	6	4
	8-year-olds	0	1	3	9	3
	10-year-olds	3	4	4	4	1
	Adults	11	4	0	1	0

[a] US data reprinted from Kelemen (1999b).

adult participants from Kelemen (1999b).[5] A 4 (age: 7-, 8-, and 10-year-olds and adults) × 2 (property type: biological vs. non-living natural kind) × 2 (function type: self-serving vs. social) mixed ANOVA compared British children's and US adults' tendency to endorse teleological explanations with the different property types. Focusing on the interactions, the analysis found a significant Age × Property Type interaction ($F(3, 60) = 7.84$, $P < 0.01$) and Property Type × Function Type interaction ($F(1, 60) = 45.57$, $P < 0.01$). The Age × Property Type effect occurred because while children and adults were equally likely to choose teleological explanations of biological properties, British children endorsed more teleological explanations of non-living natural objects than adults (Fishers LSD, $P < 0.05$). The Property Type × Function Type interaction occurred because, overall, participants' tendency to endorse self-serving teleological explanations of biological properties was greater than their tendency to endorse anything else.

Finally, because a comparison of children's responses to the non-living natural kinds was particularly central to the question of whether children have promiscuous teleological intuitions, an individual subject analysis was also conducted to explore the consistency of British and American participants' teleological responses. The results are presented in Table 2.

As Table 2 shows, only five out of 16 US adults (31%) ever endorsed a teleological response. In contrast, for both the British and American 7- and 8-year-old age groups, patterns of teleological response were substantially higher. An equal number of British and American 7-year-olds (13 out of 16 children: 81%) and an almost equivalent number of British and American 8-year-olds (15 out of 16 American (94%), 14 out of 16 British (88%)) endorsed teleological choices on two or more occasions. By 10 years of age, both American and British children were showing signs of greater conservatism with nine out of 16 American children (56%) and 11 out of 16 British children (69%) endorsing a teleological explanation on two or more occasions. In summary, as with the group responses, the pattern of individual subjects' responding to the non-living natural objects

[5] British adults were not run in this study because there was no reason to expect that their responses would differ from the scientifically-appropriate selective teleological pattern of response already found with American adults on this particular kind of forced-choice task.

showed a remarkably similar pattern of development in both British and American children.

2.3. Discussion

Consistent with the PT hypothesis, the present study found that British children share young American children's tendency to be promiscuously teleological. Like American children, they had an overall preference for teleological rather than physical explanations of the properties of both living and non-living natural kinds. Like American children, they applied teleological explanations more broadly and more frequently than adults even after they had been given cues that adults consider physical explanations appropriate to non-living natural objects. Where British and American children did differ slightly was in the details. While young American elementary school children treated body parts as though they have both biological self-serving and artifact-like social functions, British children consistently erred in favor of self-serving survival-enhancing functions for properties like necks and feet. While younger American and British children endorsed both self-serving and social teleological explanations of non-living natural kind properties over physical accounts, younger British children's teleological preferences hovered closer to chance.

Of course, the finding that children from both countries perform so contrary to Western adult intuition by endorsing teleological explanations with non-living natural object properties is striking. Because of this, it was important to rule out one further possible explanation for why younger children might have been drawn towards purpose-based explanations in these cases. Specifically, an aspect of the method in Kelemen (1999b) was that whenever a non-living natural object was introduced, the transition from the previous trial to the new trial topic (i.e. which was frequently a transition from an animal to a natural object property trial) was smoothed by prefacing the presentation with an explicit statement that the item occurred in the animal's environment (e.g. "All around where Cryptoclidus lived, there were these pointy kinds of rocks"). In addition to this, the social teleological explanations of the items usually invoked the animal as a means of motivating the function (e.g. "The rocks were pointy so that animals like Cryptoclidus could scratch on them when they got itchy"). Although intended to ease and motivate item presentation, it was however possible that inadvertently these statements introduced bias since, perhaps, children might have interpreted them as an experimenter cue that the non-living natural objects should be explained in terms of the animal's needs – a bias that would have elevated social teleological responses to the natural object properties in particular, as well as the level of teleological responding overall.

To rule out this possible explanation of the results, it was therefore decided that an additional control group of children should be run on a version of the task that eliminated these potentially biasing references. American second graders were selected as participants given the propensity of this particular academic/age group to prefer teleological explanation of natural object properties in past studies. In addition to eliminating the animal references, it was also decided that for half the group of control children, a further experimental manipulation should be introduced. In the original Study 2 method, children were given cues as to how physical explanation applies to non-living natural objects by hearing an experimenter model a "scientific" physical-reductionist explanation during the

pretrial session and then encourage participants to think in scientific terms too. This approach had the benefit of possessing some ecological validity – children are more likely to hear "appropriate" forms of explanation modeled to them rather than more explicitly trained into them even in school – but given children's imperviousness to the original cues, it was decided that it would be interesting to explore what would happen if children were even more pointedly told what form of explanation a scientist would endorse as correct. To this end, half the control children were not only presented with modified natural object property trials but also a modified pretrial tutorial session involving a forced-choice between a teleological and a physical-reductionist explanation and an explicit statement of what explanation a scientist would choose. The format of the new pretrial tutorial therefore "taught to the test" somewhat overtly.

3. Study 2: US control study

3.1. Method

3.1.1. Participants

The participants were 23 7- and 8-year-old children (9 males and 14 females; mean age: 7 years 10 months; SD = 6 months) attending Grade 2 of an urban, state-funded, ethnically diverse elementary school drawing from an urban, blue collar, largely minority community in Boston, MA. Because the time of testing was early in the school year, the children were younger than children of the equivalent academic year in the original American and British samples who had, for the most part, already had their eighth birthday. All of the control sample had received some exposure to curricula in the physical and life sciences. Relevantly, in Grade 1, they had received a module on the physical process by which clouds form.

3.1.2. Procedure

The materials, design, and procedure were the same as those in Study 2 of Kelemen (1999b) with some minor alterations. In the introduction to the non-living natural object property trials, the phrase "All around where (species name) lived, there were these (non-living natural kind category)" was replaced with "All around the country at this same time, there were these (non-living natural kind category)". This phrase related back to the introductory gloss in which children were told they would be looking at some animals and objects from "a long time ago". Also all references to stimulus set animals were removed from the social teleological explanations of the non-living natural object properties. Finally, while approximately half the children (12 children) received the original pretrial tutorial script, the remaining children heard the original version with the addition of the following lines after the description of cloud formation: "Cool! So now you know how scientists think clouds form and why they are up in the sky. They are all made up of tiny drops of water and sometimes when the water drops get really cold then it rains. So, if someone asks a scientist, "why do clouds have these fluffy parts? Do clouds have these fluffy parts so that the cloud can float across the sky easily or do clouds have these fluffy parts because tiny drops of water build up in the same place?" then a scientist would say

that "a cloud has fluffy parts because tiny drops of water build up in the same place". Now, here's what I want you to do. I want you to try and think like a scientist about some things."

3.2. Results

A preliminary 2 (tutorial script: old vs. new) × 2 (property type: biological vs. non-living natural kind) × 2 (function type: self-serving vs. social) mixed ANOVA was conducted to compare the two groups of control children in their tendency to endorse teleological explanations. As in the earlier studies, the two sets of biological property trials were collapsed together and proportion scores were used in analyses to control for the different number of property trials. The only effect that this analysis revealed was a main effect of tutorial script type ($F(1, 21) = 3.88$, $P < 0.06$). Surprisingly, the effect occurred because children who had heard the new, more explicit, tutorial were significantly more likely to endorse teleological response options than children who had heard the old tutorial ($M = 77\%$ vs. 63%). In the absence of any other effects with regard to property types (e.g. the non-living natural kinds), the data from the two control groups were therefore collapsed together for ease of further analysis.

To explore whether the removal of the potentially biasing phrases in the non-living natural objects property trials had altered children's explanatory preferences, a 3 (study: US vs. UK vs. US control) × 2 (property type: biological vs. non-living natural kind) × 2 (function type: self-serving vs. social) mixed ANOVA compared each group of second grade (or British equivalent) children's tendency to endorse teleological explanations. Table 1 presents the results.

The analysis revealed a three-way Study × Property Type × Function Type interaction which subsumed all other main effects and interactions ($F(2, 52) = 3.57$, $P < 0.05$). This interaction was further explored in four one-way ANOVAs comparing teleological responding by the three groups of children on the self-serving biological, social biological, self-serving and social non-living natural object property trials, respectively. These analyses found no differences in the teleological responding of US, UK, and US control children on self-serving biological property trials and, more importantly, no differences between the groups on the self-serving or social non-living natural object property trials. In all cases, and despite the changes to the non-living natural object property trials, the new group of US control study children had above chance preferences for teleological over physical explanations (all $P < 0.05$). The only significant difference occurred with the social biological property trials in which the children's task was to select between social teleological and physical explanations of biological properties ($F(2, 52) = 6.77$, $P < 0.01$). The effect occurred because both the original US and the new US control sample were significantly more likely to endorse other-serving teleological explanations of animal properties such as feet than British children who eschewed such explanations.

In summary, despite the removal of the potentially biasing references, the control study involving a new group of US second grade children found further support for the PT hypothesis, reproducing the preference for teleological explanation found in Study 2 of Kelemen (1999b).

4. General discussion

The present studies explored whether British children share young American children's broad preference for teleological explanations of natural phenomena. The findings indicate that, in general, they do. However, they also more selectively favor self-serving explanations of biological properties than American children and are, perhaps, slightly less certain about attributing purpose to non-living natural kinds. Such differences are subtle but may occur as a result of differences in the availability of religious-based teleological ideas. For example, it seems likely that young American children's consistently stronger endorsement of social explanations of animal properties reflects a greater cultural emphasis on notions of benevolent design.

Differences in cultural religiosity may then lead to some cultural differences in children's teleological intuitions. But while these differences should not be ignored, they should also not overshadow the overall finding of these studies, which is that early during the elementary school years British and American children's explanatory preferences are remarkably resistant to a variety of cues concerning physical explanation, remarkably teleological, in short, remarkably alike. Thus, while cultural religiosity may exert some influence on the specifics of American children's PT, it does not seem to account for its source. However, before moving to this conclusion, it is important to acknowledge an important point: a relative cultural paucity of religious/teleological explanation is not equivalent to an absence.[6] It could be argued therefore that, even though British children are less likely, on average, to be exposed to statements reinforcing the notion of intention or design in nature, the amount of exposure that they do receive is sufficient. In other words, it could be argued that children only require minor environmental support to establish a bias to promiscuously apply teleological explanation (for related suggestive evidence see Evans, 2001). Rather than deny this possibility, it seems more appropriate to ask why this should be so. What is the underlying nature of a teleological approach to explanation such that it needs only minimal cultural support to become established and then broadly overapplied to all kinds of phenomena?

According to PT, the answer is as follows: the tendency to attribute purpose to objects is easily established because its primary source is the cognitive predisposition to attribute purpose to others' actions. Children, then, promiscuously attribute purpose to objects because they intuitively compensate for absences of knowledge by drawing on their understanding of intentions and the intention-based domain of artifacts (e.g. Gelman & Bloom, 2000; Kelemen, 1999a, 2003, in relation to children's artifact knowledge). Again, because this is an approach that is psychologically natural, it needs only minimal, if any, cultural support to be maintained (for a fuller description, see Kelemen, 1999a,c,d, 2003; see also Barrett, 2000; Boyer, 1994). This is, of course, not the end of development. Over time, as Western children elaborate alternative modes of scientific explanation, the default

[6] It should be noted that while there are many societies in which religion might be as pervasive as it is in America, it would be potentially impossible to find a culture where there is a religious vacuum since religion, as a social phenomenon, appears to be a cultural universal (Atran, 2002; Boyer, 2001), extending even to those cultures sometimes characterized, in the west, as possessing non-religious belief systems (e.g. Japan, China) (for discussion see Guthrie, 1993; also Momen, 1999; Spiro, 1966; Tambiah, 1970).

tendency to treat objects as quasi-artifacts is reweighted in that it simply becomes one explanatory strategy in a repertoire of many, only being invoked for certain phenomena in certain contexts depending on what is perceived as culturally appropriate. For example, Western cultural norms may deem it appropriate for individuals to limit teleological explanation to discussions of biology or behavior in an academic context but outside of that context, cultural norms may vary.

PT therefore proposes no fundamental discontinuity between children's and adults' capacity for teleological reasoning. Instead, it suggests that Western-educated adults have the potential to be as promiscuously teleological as children but are not because they have richer explanatory repertoires and a greater knowledge of cultural norms – norms which can differ a great deal between cultures. For example, in America, the degree to which religious ideas have cultural acceptability seems to lead to fewer constraints on the public expression of teleological ideas by adults, even those residing in an academic community. Thus, while American college-educated (university town resident) adults endorse a "selective teleology" in the scientific experimental context, they are more willing than British college-educated (university town resident) adults to respond with teleological explanations of natural phenomena in other "open-ended" contexts. This cross-national result is not only interesting in itself, but also because it has implications for children's theory development: recent research finds that when responding to their preschool children's "why?" questions about non-living natural phenomena, some California-based (Mexican descent) parents provide teleological explanations almost as often as they provide causal explanations. For example, when asked a question such as "why does it get dark?" some parents are almost as likely to give a reply such as "because we have to go to sleep" as they are to say "because the sun has gone away" (Kelemen, Callanan, Casler, & Pérez-Granados, 2003). In some American children then, development of promiscuous teleological intuitions may receive additional support from some adults. To what extent this is also true in Britain, despite adults' reluctance to publicly engage in religious/teleological explanation, is a question that still awaits an answer.

In summary, British and American children have a promiscuous tendency to teleologically explain the properties of both living and non-living natural kinds in terms of a purpose. One proposal is that this bias occurs because, during development, across cultures, children primarily adopt an artifact model when reasoning about the natural world (see also Evans, 2000; Kelemen, 2003; Kelemen & DiYanni, 2003; Piaget, 1929). There are several implications if this interpretation turns out to hold truth: from a theoretical standpoint, it suggests that while teleological thought may play a crucial role in children's early reasoning about living things, its presence is not necessarily indicative of a truly "biological" mode of construal (Atran, 1995; Keil, 1992; see also Opfer & Gelman, 2001) but rather a way of thinking that has its roots in intentionality (Carey, 1985, 1995; Kelemen, 1999d; see also Hatano & Inagaki, 1999). From an educational standpoint, it helps to explain why people consistently misinterpret natural selection as a quasi-intentional, designing force rather than as a blind physical mechanism.

Of course, having established that the finding of a childhood "promiscuous teleology" generalizes between similar cultures that differ in religiosity, a further step for research is to discover whether the same effects hold between other more disparate cultures – ones that, perhaps, have much greater similarity in popular religiosity but instead differ along

many other dimensions including level of scientific advancement, availability of education and social organization. In many respects, however, such a comparison would be more interesting in terms of what it might reveal about cross-cultural differences between adults', rather than children's, teleological intuitions since it is not clear, given the present results, on what basis young children would be predicted to differ (except, perhaps, in the degree to which their promiscuous teleological intuitions are more or slightly less pronounced). In contrast, adults might be expected to differ substantially since part of the PT proposal is that it is the cultural value placed on physical-reductionist "scientific" thinking that is often significant in holding Western adults' promiscuous teleological tendency in check. Such a comparison is, however, for future discussion (Casler & Kelemen, 2003).

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Appendix A. Study stimuli

A.1. Cryptoclidus (aquatic reptile)

Biological Property 1: Cryptoclidus had these long necks.
Why do you think they had such long necks?
PH. They had long necks because the stuff inside got all stretched out and curved.
SS. They had long necks so that they could grab at fish and feed on them.
SOC. They had long necks so that they could hold up their friends when they got tired swimming.
Biological Property 2: Cryptoclidus had smooth skin.
Why do you think they had such smooth skin?
PH. They had smooth skin because it got stretched out tight across their bones.
SS. They had smooth skin so that they could move easily through the water.
SOC. They had smooth skin so that other animals could swim alongside without getting cut.
Natural Kind Property: All around where Cryptoclidus lived, there were these pointy kinds of rocks.
Why do you think the rocks were so pointy?
PH. They were pointy because little bits of stuff piled up on top of one another over a long time.
SS. They were pointy so that animals wouldn't sit on them and smash them.

SOC. They were pointy so that animals like Cryptoclidus could scratch on them when they got itchy.

A.2. Macreuchenia (large terrestrial mammal)

Biological Property 1: Macreuchenia had these big snouts.
Why do you think they had such big snouts?
PH. They had big snouts because their face muscles and bones pulled down and got longer.
SS. They had big snouts so that they could pull down leaves from trees and eat them.
SOC. They had big snouts so that they could stroke their babies and make them feel loved.
Biological Property 2: Macreuchenia had a big body.
Why do you think they had such big bodies?
Ph. They had big bodies because of the way all their fat deposits collected around their muscles.
SS. They had big bodies so that they could push a path through all the trees in the forest.
SOC. They had big bodies so that smaller animals could shelter underneath them from the rain.
Natural Kind Property: All around where Macreuchenia lived, there were these very still kinds of ponds – ponds that never had waves.
Why do you think the ponds were so still?
PH. They were still because no moving water ever ran into them.
SS. They were still so that they would never spill and lose all their water.
SOC. They were still so that animals like Macreuchenia could cool off in them without being washed away.

A.3. Mononykus (terrestrial bird)

Biological Property 1: Mononykus had these long tails.
Why do you think they had such long tails?
PH. They had long tails because their feathers were big and stuck out from behind their body.
SS. They had long tails so that they could keep balance while they ran.
SOC. They had long tails so that their behinds were covered and other animals could look without getting embarrassed.
Biological Property 2: Mononykus had soft feathers on their bodies.
Why do you think they had such soft feathers?
PH. They had soft feathers because furry stuff got built up all over them and pressed together in a certain way.
SS. They had soft feathers so that they could look like leaves on trees and stay hidden.
SOC. They had soft feathers so that other tiny animals could crawl under them and stay warm and protected.
Natural Kind Property: All around where Mononykus lived, there was this grainy (rough) kind of sand.
Why do you think the sand was so grainy?

PH. It was grainy because bits of shells got broken and mixed up making it that way.
SS. It was grainy so that it wouldn't get blown away and scattered by the wind.
SOC. It was grainy so that animals like Mononykus could easily bury their eggs in it.

A.4. Moeritherium (squat mammal)

Biological Property 1: Moeritherium had these flat feet.
Why do you think they had such flat feet?
PH. They had flat feet because their toe bones got shortened and all smoothed out.
SS. They had flat feet so that they could stand on wet ground without slipping.
SOC. They had flat feet so that they could have fun playing and kicking mud on each other.
Biological Property 2: Moeritherium had a wide back.
Why do you think they had such wide backs?
PH. They had wide backs because they had large bones that got joined together in a particular way.
SS. They had wide backs so that their bodies would be strong and firm.
SOC. They had wide backs so that birds and other animals could ride around on top off them.
Natural Kind Property: All around where Moeritherium lived, there were these green kinds of stones.
Why do you think the stones were so green?
PH. They were green because lots of colored stuff mixed together to make them that way.
SS. They were green so that they couldn't be seen in the grass and no-one would pick them up and take them.
SOC. They were green so that animals like Moeritherium could live in a nice place with pretty things around them.

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: Clarendon Press.

Atran, S. (2002). *In gods we trust*. New York: Oxford University Press.

Barrett, J. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, *4*, 24–29.

Boyer, P. (1994). Cognitive constraints on cultural representations: natural ontologies and religious ideas. In L. A. Hirschfeld & S. Gelman (Eds.), *Mapping the mind: domain specificity in cognition and culture* (pp. 391–411). New York: Cambridge University Press.

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

Bruce, S. (1999). *Choice and religion: a critique of rational choice theory*. Oxford: Oxford University Press.

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

Carey, S. (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. 268–302). Oxford: Clarendon Press.

Carter, S.L. (2000). *God's name in vain: the wrongs and rights of religion in politics*. New York: Basic Books.

Casler, K., & Kelemen, D. (2003). Teleological explanations of nature among Romanian Roma (Gypsy) adults. Manuscript in preparation.

Coley, J. (2000). On the importance of comparative research: the case of folkbiology. *Child Development*, *71*, 82–90.

Davis, J., & Smith, T. (1991). *General Social Survey 1991*. Chicago, IL: National Opinion Research Center.

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.

Demerath, N. J. (1998). Excepting exceptionalism: American religion in comparative relief. *Annals of the American Academy of Political and Social Science*, *558*, 28–40.

Edwords, F. (1987). The religious character of American patriotism. *Humanist*, *47*, 20–24.

Evans, E. M. (2000). 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*. Cambridge: Cambridge University Press.

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

Gelman, S. A. (1988). Development of induction within natural kind and artifact categories. *Cognitive Psychology*, *20*, 65–95.

Gelman, S., & Bloom, P. (2000). Young children are sensitive to how an object was created when deciding what to name it. *Cognition*, *76*, 91–103.

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.

Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking the intentional stance at 12 months of age. *Cognition*, *56*, 165–193.

Guthrie, S. (1993). *Faces in the clouds: a new theory of religion*. New York: Oxford University Press.

Harris, J. R. (1998). *The nurture assumption*. New York: Touchstone.

Hatano, G., & Inagaki, K. (1999). A developmental perspective on informal biology. In D. L. Medin & S. Atran (Eds.), *Folkbiology* (pp. 321–354). Cambridge, MA: MIT 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: Erlbaum.

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: Clarendon Press.

Kelemen, D. (1999a). The scope of teleological thinking in preschool children. *Cognition*, *70*, 241–272.

Kelemen, D. (1999b). Why are rocks pointy? Children's preference for teleological explanations of the natural world. *Developmental Psychology*, *35*, 1440–1453.

Kelemen, D. (1999c). 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: Oxford University Press.

Kelemen, D. (1999d). Functions, goals and intentions: children's teleological reasoning about objects. *Trends in Cognitive Sciences*, *12*, 461–468.

Kelemen, D. (2003). Are children intuitive theists? Reasoning about purpose and design in nature. *Psychological Science* (in press).

Kelemen, D., Callanan, M., Casler, K., & Pérez-Granados, D. (2003). "Why things happen": teleological explanation in parent-child conversations. Manuscript submitted for publication.

Kelemen, D., & DiYanni, C. (2003). Children's ideas about nature: the role of purpose and intelligent design. Submitted for publication.

Kelemen, D., Widdowson, D., Posner, T., Brown, A., & Casler, K. (in press). Teleo-functional constraints on preschool children's reasoning about living things. *Developmental Science*.

Kelley, J., & De Graaf, N. D. (1997). National context, parental socialization and religious belief: results from 15 nations. *American Sociological Review*, *62*, 639–659.

Kosmin, B., & Lachman, S. (1993). *One nation under God: religion in contemporary American society*, New York: Harmony Books.

Lippy, C. H. (1994). *Being religious, American style: a history of popular religiosity in the United States*, Westport, CT: Greenwood Press.

Lipset, S. M. (1996). *American exceptionalism: a double-edged sword*. New York: W.W. Norton.

Madsen, D. (1998). *American exceptionalism*. Jackson, MS: University Press of Mississippi.

Marty, M. E. (1987). *Religion and republic*. New York: Beacon Press.

Massey, C., & Gelman, R. (1988). Preschoolers decide whether pictured unfamiliar objects can move themselves. *Developmental Psychology*, *24*, 307–317.

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

Momen, M. (1999). *The phenomenon of religion: a thematic approach*, Oxford: Oneworld.

Opfer, J., & Gelman, S. A. (2001). Children's and adults' models for predicting teleological action: the development of a biology-based model. *Child Development*, *72*, 1367–1382.

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

Reichley, J. A. (1985). *Religion in American public life*. Washington, DC: The Brookings Institute.

Smith, T. (1998). *General Social Survey 1998*, Chicago, IL: National Opinion Research Center.

Solomon, G., Johnson, S., Zaitchik, D., & Carey, S. (1996). Like father, like son: young children's understanding of how and why offspring resemble their parents. *Child Development*, *67*, 151–171.

Sperber, D. (1996). *Explaining culture: a naturalistic approach*. Oxford: Blackwell.

Spiro, M. (1966). Religion: problems of definition and meaning. In M. Banton (Ed.), *Anthropological approaches to the study of religion* (pp. 85–126). London: Tavistock.

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

Tambiah, S. J. (1970). *Buddhism and the spirit cults in North-East Thailand*. Cambridge: Cambridge University Press.

Tickle, P. (1997). *God-talk in America*. New York: Crossroads.

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.

Warner, R. S. (1993). Work in progress toward a new paradigm for the sociological study of religion in the United States. *American Journal of Sociology*, *98*, 1044–1093.

Wilson, J. (1979). *Public religion in American culture*. Philadelphia, PA: Temple University Press.

Woodward, A. (1998). Infants selectively encode the goal of an actors reach. *Cognition*, *69*, 1–34.