Function, goals and intention: children's teleological reasoning about objects

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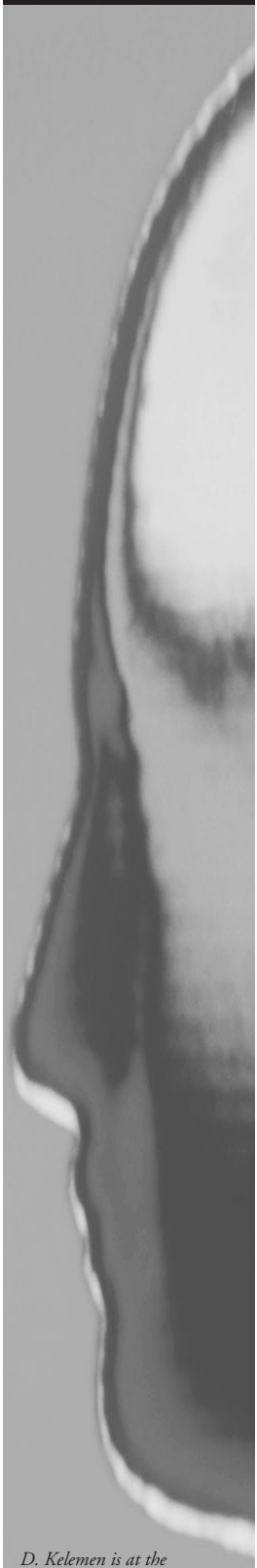
A fundamental aspect of adult thought is the 'teleological' tendency to assume that objects exist for a purpose. When seeing an unfamiliar artifact or strange anatomical part on an animal, the first question an adult will usually ask is 'what's that for?' – a query that assumes that the object can be teleologically explained in terms of its function. Current debate focuses on the origin and scope of teleological thought, and its role in children's emerging theories of the biological world. The bias to view objects as 'designed for a purpose' probably derives from children's privileged understanding of intentional behavior and artifacts. This makes children prone to a 'promiscuous teleology' in which artifacts and natural objects of all types are viewed as existing for a function. Because of this, I argue that we should be cautious about taking the existence of an early teleological bias as evidence that there is biological understanding that exists independently of a psychological construal of living things.

The 'teleological' tendency to assume that objects exist for a purpose is a fundamental aspect of adult thought. Indeed, it takes only a cursory examination of everyday thinking to realize how central teleological thinking is. When encountering an unfamiliar artifact or strange body part on an animal for the first time, the question an adult will usually ask is 'what's that for?' – a query that assumes the object can be teleologically explained in terms of its function. This way of thinking is, in itself, highly functional: it helps us to constrain our hypotheses about why objects exist and have the properties that they do. It also helps to guide our assumptions about their future behavior and the role that these objects might have in the larger scheme of human or natural events[1]. In short, the teleological–functional tendency to view objects and events as 'designed for a purpose' is a crucial feature of intuitive theory building. The study of teleological thought is therefore an important part of a broader program of research that is concerned with the origin and development of various domain-specific theoretical capacities, such as 'theory of mind' and 'folk biology'.

In this article, two questions that have driven recent research on this topic are addressed. First, what is the relationship between children and adults in their teleological–functional construal of objects? Second, how does the teleological tendency to view objects as 'designed for a purpose' originate? I will argue that, despite similarities between teleological–functional intuitions in young children and adults, young Western-educated children reason in teleological–functional terms about a broader variety of phenomena than do Western-educated adults. In addition to biological parts and artifacts, they view non-biological natural kinds and their properties as existing 'for' purposes – a finding that has implications for proposals that teleological reasoning in young children is selective[2] and is the earliest form of thought that is specifically biological[2]. With respect to origins, several proposals have been made. One possibility is that the bias to view objects as 'made for something' derives from an early sensitivity to intentional agents and their behavior as intentional object users and object makers. The subsequent development of a promiscuous teleological bias to explain all kinds of phenomena in terms of a purpose might occur because young children draw on their early privileged knowledge of intentional behavior, and, in the absence of other explanations, treat objects of all kinds as quasi artifacts that have been intentionally caused. This view contrasts with proposals that teleological–functional thought is, itself, a primary building block of infant cognition[2]. It also differs from the view that the teleological–functional tendency derives from a non-intentional understanding of agency[3] (see also Ref. 4) or that it is a consequence of conceptually undifferentiated, precausal 'artificialist' thought in children[5].

The relationship between children's and adult's teleological construal of objects

Piaget was the first developmental psychologist to suggest that children have a bias to view objects as designed for a purpose[5].



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Box 1. The relationship between teleological thought and a vitalistic biology

Space limitations prevent a more-detailed overview of the literature on intuitive biology in children (see Refs a,b for reviews); however, a further significant proposal regarding the status of children's reasoning about living things is relevant to this article. Consistent with Keil and others (Refs c,d), Hatano and Inagaki claim that, by preschool age, children have a distinct conception of biology (Refs e–g). However, in contrast to other theorizers, Hatano and Inagaki argue that although its development is constrained by uniquely biology-specific beliefs (that is, living things differ from non-living things by engaging in growth and other life-sustaining processes), this autonomous biological domain does not exist at the outset of life: it occurs subsequent to the emergence of psychological and physical reasoning, and undergoes substantial conceptual revision to become an adult-like mechanistic biology.

Specifically, Hatano and Inagaki propose that children's 'folk biology' develops from its own distinct mode of explanation, which they label 'vitalistic causality'. Vitalism involves the idea that bodily processes occur through the actions of an internal organ that has 'agency' insofar as it can initiate activities – something that the organ achieves through the goal-directed physical transmission of 'vital force', which is a type of life-maintaining energy. To provide an example, in response to the question 'why do we take in air?', Hatano and Inagaki suggest a vitalistic response is 'because our chest takes in vital power from the air'. This contrasts with an intentional response 'because we want to feel good' and a mechanical response 'because the lungs take in oxygen and change it into useless carbon dioxide' (Ref. g). As this example should indicate, the 'organ agency' of vitalistic explanations is therefore a non-intentional form of goal-directed action. Like Keil's teleo–functional stance then, vitalism is an independent mode of construal that makes children sensitive to biological phenomena via a conception of purpose that is non-intentional in nature. This similarity has led to the suggestion that Hatano and Inagaki's proposal of vitalism might ultimately reduce to Keil's claims concerning the teleological stance, particularly as vitalism implicitly embodies the teleological–functional concept that internal organs exist for the purpose of maintaining life (Ref. h.) However, while Hatano and Inagaki acknowledge that vitalism and teleology might be somewhat complementary, in recent publications, they have been careful to differentiate their position from Keil's claims that early biological understanding is primarily structured by the view that objects are 'for' something (Ref. i). They stress that vitalism is 'biology-specific' and does not apply to artifacts in the way that teleological thought does. They also note that because vitalistic explanation focuses on the *way* an internal organ sustains life, it might be closer to mechanistic explanation than teleological explanation (which focuses on 'why' it sustains life; Refs e–g,i). Finally, they have also recently suggested that while it is distinct, children's conception of 'organ agency' almost certainly relies on, and 'borrows' from, a prior understanding of intentional 'person' agency (Ref. i). Further resolution of questions concerning the actual developmental relationship between these different modes of construal awaits future research – as does the question of whether young children really are 'vitalists'. In support of the claim that they are, Inagaki and Hatano have found that by six years of age, Japanese children prefer vitalistic explanations of bodily processes to intentional and mechanistic explanations (Ref. g). However, shortcomings to Hatano and Inagaki's methods have been raised (Refs h,j) and the cross-cultural generalizability of their findings to cultures that have no recent history of vitalist thought is still unclear (Ref. j).

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He argued that young children are 'artificialists' who believe that all living and non-living things originate from human action: a misconception that arises, he argued, because children do not possess the ability to reason in physical–causal terms. Piaget's assertion that children conflate the artificial and natural worlds because they are 'precausal', has since been undermined by research indicating that children are proficient physical reasoners from early infancy[6–8]. Nevertheless, the questions he raised about the way teleological assumptions influence children's conceptions of the natural world still motivate current psychological research on teleological thought. Specifically, much of the contemporary work has occurred in the context of the debate over folk biological theory in children. At the heart of this dispute is the question of whether young children understand living things as vital, physiological organisms in a manner that is independent of their psychological construal of animals as intentional beings. Following proposals by Carey[9], one school of thought argues that children do not have this kind of autonomous biology until at least six to ten years of age[10–12]. By contrast, another school of thought argues that young children possess a distinct biological domain at a far earlier age[2,13–20]. One of the most influential of these latter proposals has been made by Keil, who suggests that children possess a rudimentary biology from the outset of development, and that an innate teleological tendency to view entities as 'designed for a purpose' forms its core[2,13–15] (see also Refs 16,21). More precisely, Keil argues that, from early in development, domain-specific reasoning in children is constrained by adult-like teleological ideas[2]. Like adults, children view artifacts such as chairs, and biological properties such as ears, as existing to perform functions. However, they are also aware of the differences between these object domains, recognizing that, while artifacts exist to serve external agents, biological traits exist for the physiological good of organisms themselves – an understanding that, Keil suggests, is in itself, indicative of a rudimentary sensitivity to biological causality. This biological awareness is further underscored, Keil argues, because, when considering the natural world, children and adults restrict their teleological construal to the properties of living things. They, therefore, differentiate them from non-living natural objects, such as mountains, which they view in entirely nonfunctional

terms. Keil's proposal of an innate 'teleological stance' therefore rests on two claims. The first is that, like adults, preschool children have selective ways of teleologically interpreting the world. The second is that the teleological stance is a primary component of human cognition – one that exists independently of other basic construals such as a physical or an intentional stance (see Box 1). Turning to the first of these claims, exactly how equivalent are teleological intuitions in adults and young children?

Similarities between children and adults

Recent findings certainly suggest that children and adults share strong similarities in their functional construal of artifacts and biological parts. Importantly, for example, both preschoolers and adults constrain their reasoning about the functions of artifacts and biological parts by considering their origin. Thus, when children and adults are shown novel body parts and artifacts that were designed for one thing but intentionally or accidentally used for some other activity, they agree that the object is 'for' the activity it was originally designed (either by nature or intention) to perform (see Fig. 1)[22] (but see also T. German and S.A. Johnson, unpublished).

However, the similarities extend further than this. Consistent with the proposal that, from an early age, children have an adult-like sensitivity to different functional relations in the artifact and biological realms, Keil finds that, when presented with comparable features on a biological part and an artifact, even three-year-olds consider the biological part as 'self-serving' but the parallel part on an artifact as 'other serving'[15]. Thus, young children know that while a barb on a rose is good for the rose, a barb on barbed wire is good for someone else.

A final similarity is that, like adults, young children draw on teleological assumptions about functional design in order to constrain their inferences about unfamiliar living things. In one study, three-, four- and five-year-old children were taught behavioral properties of two animals and were then asked which behavioral property applied to an unfamiliar third animal (a creature that shared overall similarity with one of the training animals but was dissimilar to the other with which it shared only a specific functional trait). The study found that, from three years of age, children preferentially attended to common functional features, rather than overall similarity, when making inductions about the behavior of the novel animal (D. Kelemen, D. Widdowson, T. Posner, A.L. Brown and T. Dennis, unpublished) (see Fig. 2).

Taken together, these findings generate support for the contention that children have an adult-like teleological sense when reasoning about the biological and artifact domains. However, the picture is, of course, more complicated than this. Other studies have also found significant differences in the teleological intuitions of children and adults – differences that suggest caution when using the tendency of children to engage in purpose-based thought as a basis for attributing an autonomous biology.

Differences between children and adults

As mentioned earlier, Western-educated adults usually restrict their teleological construal of the natural world to biological structures. For example, noses are viewed as *for*

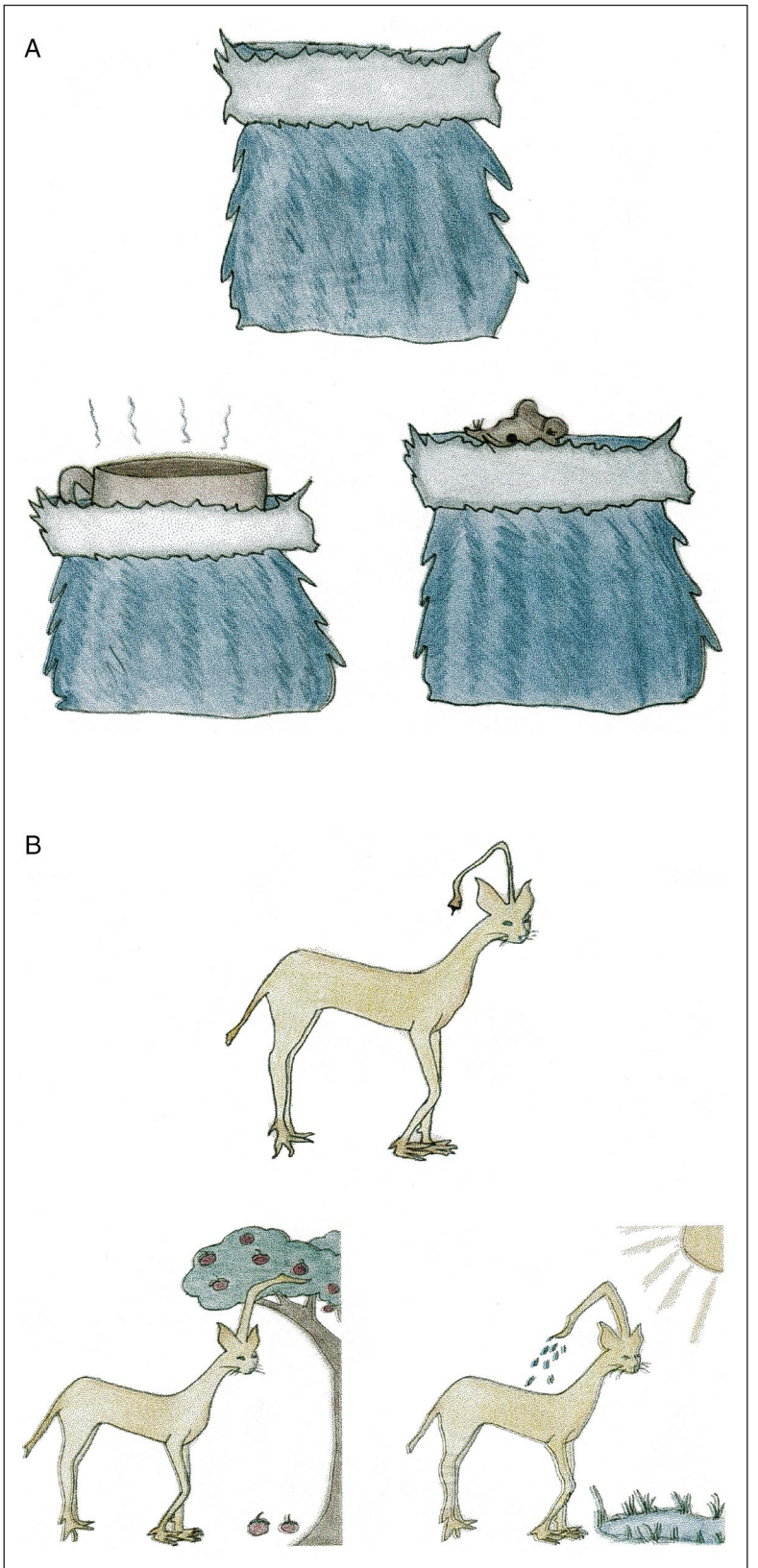

Fig. 1. The conception of artifact and body-part function in preschoolers and adults. In this study, participants were told about objects that were designed for one activity, never used for it, and then accidentally or intentionally used for something else[22]. For example, in the artifact trial shown **(A)**, Lucy made the object to keep coffee warm. She then gave it to Joe who, depending on the experimental condition, accidentally or intentionally ended up putting his hamster in it, once or frequently. Both preschoolers and adults agreed that the objects were 'for' their original function regardless of the alternative use. **(B)** The same results were obtained with body parts. In this example, animals called 'footles' generally use their body part to knock fruit off trees. One footle never does that and accidentally or intentionally splashes cool water on himself, once or frequently.

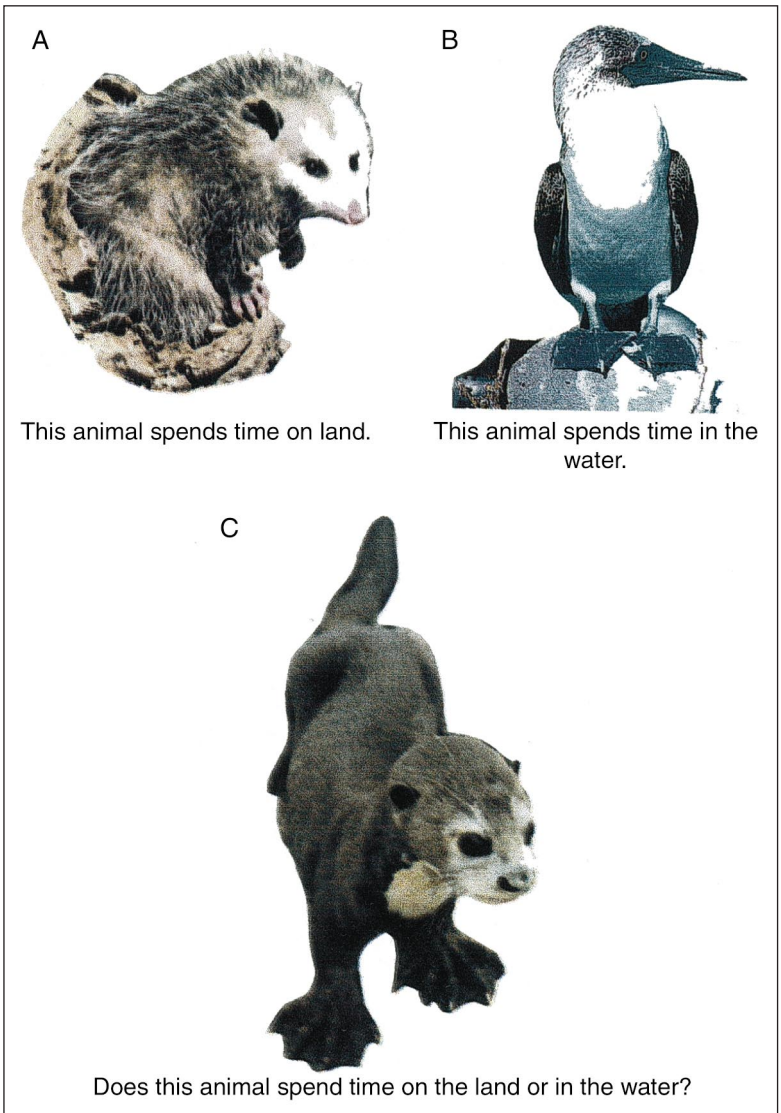

Fig. 2. Intuitions about function constrain children's inferences about animals. Results suggest that, from three years of age, children use their knowledge of functional design as a basis for generalizing behavioral properties. For example, when presented with triads as shown, children eschew overall similarity as a basis for judgment, attending instead to common functional parts. Thus, regardless of its resemblance to the weasel **(A)**, children conclude that the otter **(C)** (target animal) 'spends time in water', like a dissimilar booby bird **(B)**, with which it shares the functional property of webbed feet (D. Kelemen *et al.*, unpublished).

smelling odors because, despite other activities that they perform (for example, holding up spectacles), this first activity seems to explain why noses exist and have the properties that they do. By contrast, even though a non-living natural kind, such as a cave, might perform many activities (growing stalagmites, providing a habitat for bats), adults do not tend to view these activities as the *raison d'être* of the cave in any teleological sense. Instead, these activities are likely to be viewed as consequences of the mechanical forces that caused the cave to form rather than explanations for why it formed. For adults who are educated in the West then, the living and non-living natural worlds are demarcated along teleological lines. This type of 'selective teleology' is an organization that, Keil suggests, is paralleled in young children[2,15] (see Box 2).

However, despite initial research supporting this contention (see Box 3), several recent findings challenge the idea that children are selectively teleological about the natural world. For example, in one study, preschoolers and adults were asked what they thought living things, artifacts, non-living natural objects and their physical parts were 'for', while explicitly being given the option of saying they were not 'for' anything. In contrast to adults, who selectively assigned functions to biological properties, artifacts and their parts, four- and five-year-old children responded by stating a function for almost every type of object and part. As a result, in addition to noses, clocks and pockets, children also stated functions for non-living natural objects, such as mountains ('for climbing') and clouds ('for raining'), and whole living things, such as babies ('for loving') and animals ('for walking around')[22].

A second study then checked whether children really viewed these activities as teleological functions or simply things that the objects could characteristically do or be used to do. Preschoolers and adults listened to two characters discuss whether different artifacts, living things and non-living natural kinds are 'made for something' or not. For example, in one case, the characters debated whether a tiger is 'made for something', such as 'walking and being in a zoo', or whether tigers 'aren't made for anything' and 'these are just things it does'. Participants then indicated which character they agreed with. As in the previous case, the study found that while adults were discriminating, preschoolers broadly asserted that entities of all types are 'made for something'[22].

These findings suggest that, rather than being selectively teleological, preschoolers possess a general teleological bias – a 'promiscuous teleology' that a further study has found to persist into elementary school. In the study, adults and seven-, eight- and ten-year-old children were presented with physical and teleological explanations for the properties of both unfamiliar animals and non-living natural objects. For example, participants were shown a picture of a prehistoric reptile and asked whether it had a long neck 'so that it can catch fish' (teleological) or 'because the stuff inside got all stretched out and curved' (physical). Participants were also shown a picture of a pointy rock and asked whether it was pointy 'so that animals would not sit on it and smash it' (teleological) or 'because little bits of stuff piled up over a long period of time' (physical). The results found that unlike older children and adults, who restricted their teleological view to biological properties, seven- and eight-year-olds endorsed teleological explanations for both biological and non-biological natural objects. In other words, younger children not only explained animal properties, such as long necks, in terms of a purpose, but also used this kind of explanation for non-biological natural properties, such as pointy rocks. Remarkably, this tendency remained robust even after children heard a pretrial that described, in non-teleological terms, the physical process by which natural kinds, like clouds, form[23].

In summary, when considering the natural world, children and adults display similar teleological assumptions about biological properties. They construe the functions of body parts in terms of original design, and constrain inferences about living things on a teleological basis. However, children also differ from adults by assigning functions to non-living natural kinds. This tendency raises questions about whether the bias in children to think in functional terms about animal properties is really evidence that they possess a 'biological' understanding, as Keil and others suggest[2,19]. In addition, as

Box 2. Teleological intuitions in adults

Contemporary Western-educated adults generally possess a 'selective teleology' that restricts their teleological reasoning about function to biological aspects of the natural world. However, it should be mentioned that in the context of history, this seems to be a rather recent development, prompted largely by the emergence of a secular, mechanistic science during the 17th century and the popularization of evolutionary ideas in the 1800s (Refs a–d). Prior to this, supernatural teleological explanations were the primary mode of explaining the apparent design and goal-directed character of nature, and historical evidence suggests that adults were broadly, rather than selectively, teleological. Thus, it was not only complex body parts such as eyes that were viewed as artifacts of God. Teleological explanations were also extended to non-biological natural phenomena, particularly those that were seen as most central to supporting life. The earth, its elements and topographical features were therefore considered to be part of a carefully crafted system, created to meet the needs of living things. While less prevalent, ideas such as these still endure in cultural groups who intentionally reject modern scientific explanations, or have not had significant exposure to them, although it is a matter for debate whether (in the former case) such individuals assign a special status to their intention-based teleological explanations that effectively partitions them from other 'everyday' ways of interpreting objects and events in the world (Refs e,f).

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Carey notes, functional ascription to living things is, by itself, no indicator of a biological conception unless the functions stated are understood as relevant to biology-specific goals, such as self-preservation[10]. Although prior findings suggest that three-year-olds understand that biological parts, such as rose barbs, exist for 'self-benefit', it is intriguing that in the elementary-school study just described, seven-year-old children were not only willing to endorse physiologically relevant 'self-serving' functions to biological properties, but also artifact-like 'other serving' functions. Until these differing patterns of findings are better understood, any strong claim of truly 'biological' teleological-functional theorizing in young children seems premature.

The origin of the teleological bias

Unlike Western-educated adults, children extend teleological thought to both biological and non-biological natural kinds. How do these promiscuous teleological intuitions originate? In this section, the discussion is restricted to three possible alternatives (although it should be noted that, even if not stated explicitly by their authors, additional explanations could certainly be derived from the substantial literature on the development of theoretical ideas in children).

One explanation for the existence of a broad teleological bias can be provided by one possible formulation of Keil's hypothesis. Perhaps, rather than having selective, adult-like intuitions, children innately possess a highly generalized teleological construal as a fundamental building block of cognition. This tendency then becomes refined and restricted over the course of development via some kind of general learning process (see Ref. 24 for further discussion). However, while it presents a straightforward nativist explanation of why children might be promiscuously teleological, there are some provocative questions, from an evolutionary perspective, for this type of account. Specifically, why would we have evolved, as a theoretical primitive, a nonspecific tendency to view objects as designed for a function? What adaptive advantage caused us to develop a basic mode of cognition that has no *a priori* links to any content domain[24]? Several responses could be elaborated to answer this question, but it is not clear which one such an account might favor, particularly

Box 3. Evidence for 'selective teleology' in young children

Keil explicitly explored whether children limit their teleological ideas about the natural world to biological properties (Ref. a). In the study, kindergarten and second-grade children were shown either an emerald or plant and were asked to choose between two explanations for the object's green appearance: a teleological explanation (for example, they are green because it helps there be more of them) and a physical explanation (for example, they are green because tiny parts mix together to give them a green color). As Keil predicted, while the second-grade children preferred teleological explanations for plants, they preferred physical explanations for emeralds. The intuitions of kindergarten children also showed non-significant trends in the same direction. However, while the findings of this study are suggestive, there are difficulties interpreting these results. Specifically, the wording of the teleological explanations always involved verb phrases such as 'p *helps* there be more q' or 'it *is better for* q to have p' – expressions that people tend to use with living things, given that such entities are more likely to be the recipients of aid than inanimate objects such as stones. As a result, children might have applied these phrases more to biological than non-biological natural entities because they associated them with living things and not because they were responding to teleological content.

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as Keil has cautioned against the assumption that the teleological stance has any hard-wired connections to either the biological or artifact domains[24].

Turning to a second possibility, 'Promiscuous Teleology' (PT; Refs 21–23) argues that we find purpose-based explanations compelling because teleological reasoning derives from a mode of thought that comes easily to us, owing to our evolution as social animals: intentional reasoning. In other words, our ability to attribute purpose to objects might derive from our ability to attribute purpose to the minds of agents: a capacity that is canalized in humans[25], develops early in life in human infants[26,27] and has a profound adaptive value among primates[28–31]. Promiscuous Teleology's developmental account goes as follows.

Within the first 9 to 18 months of life, infants demonstrate an increasing understanding that agents act on the basis of goals[26,32–34]. They complete unfinished goal-directed actions modeled by human and non-human actors[32] (see also S.A. Johnson *et al.*, unpublished), predict the outcome of goal-directed movements by agents[33] and generate expectations about the goal object of an actor's reach[34]. Around this time, or shortly thereafter, children also show sensitivity to the fact that agents use objects to achieve their goals. For example, 12-month-old infants will imitate a goal-directed action that causes an object to achieve some goal state, but will not imitate an apparently arbitrary action on the object, even though it causes the object to achieve a similar end state[35]. By 13–18 months of age, children also display a good working knowledge of the ways that familiar and unfamiliar artifacts can be used to fulfill goals[36–39]. This early awareness of intentional object use might have a powerful role in the elaboration of explanatory mechanisms, particularly as, during infancy, most of the objects that children encounter are artifacts, whose presence in their environment is explained by the way agents use them as means to achieving their own ends (see also Ref. 40). Experiences that suggest objects exist in the world to fulfill the purposes of agents, might subsequently contribute to the tendency to over-generate purpose-based teleological explanations when faced with explanatory gaps. In other words, later on, in the absence of other explanations, children might draw on their privileged knowledge of intentions and artifacts to conclude that, like artifacts, natural objects exist in the world because some agent put them there for a purpose (see Ref. 41 for evidence in support of this).

This proposal might seem reminiscent of earlier proposals by Piaget that children are 'artificialists' who believe that all things are made by humans[5]. While it is related, several features distinguish it from Piaget's view. First, Piaget argued that children reason in terms of human causes because they are precausal thinkers, unable to abstract away from their everyday experience and thus incapable of discriminating artifacts and natural kinds conceptually. The present proposal does not share these assumptions. Children's thoughts are neither precausal nor particularly concrete (see Ref. 17 for review). Furthermore, preschoolers distinguish artifacts from natural kinds, recognizing that not all objects and events are literally caused by people[42]. However, while they might know that human action is not the root cause of all natural objects and events, children might nevertheless rely upon the underdetermined idea of some other non-human form of agency as an alternative placeholder explanation (see S.A. Johnson, A. Booth and K. O'Hearn, unpublished, for evidence that such an abstract concept of agency might be present from infancy). In this sense, children might not be the conceptually restricted 'artificialists' that Piaget thought they were, although the PT hypothesis certainly concurs with the Piagetian view that intentional explanations have a degree of explanatory primacy in childhood – albeit for different reasons from those that Piaget suggested. Second, in contrast to Piaget, PT does not view the teleological construal as indicative of an immature stage of thought from which sophisticated thinkers emerge. Instead, it argues that a tendency to generate intention-based teleological explanations is a fundamental human propensity – one that remains as a default strategy throughout development, even in individuals who have elaborated alternative ways of accounting for phenomena (see also Refs 21,43). In this sense, PT also diverges from a prevailing model of domain-specific conceptual change, which suggests that children are theory revisionists, in the same way that scientists are[44,45].

Promiscuous Teleology's view of the origins of the teleological–functional tendency offers a viable alternative to Keil's concept of an innate teleological stance. However, recent work by Gergely, Csibra and their colleagues offers yet another interesting option[3,33].

In several studies, Gergely *et al.* [33] have shown that 9–12-month-old infants are sensitive to the goal-directed actions of abstract computer-animated figures. In one study, infants were habituated to an event in which a small circle repeatedly approached a large circle by 'jumping over' a large rectangle. It was found that when infants were presented with a test display in which the barrier was removed, they looked longer if the small circle continued its familiar 'jumping' approach than when it took a novel, but more-direct, straight-line path. In other words, infants seemed surprised when the small circle did not adopt the more-expedient novel pathway to the goal. Importantly, however, Gergely and Csibra contrast with other researchers in that they do not interpret this finding as evidence that nine-month-old infants are reasoning about the animated agent's intentional goals[23,46,47]. Instead, they suggest, infants are adopting the 'principle of rational action': a non-mentalistic precursor to the intentional stance in which goal-directed events are predicted without attributing goals to any agent but on the basis of assumptions about what constitutes rational action in the world.

This hypothesis raises an intriguing possibility with respect to the origins of a functional construal of objects. Perhaps the ability to reason about the purpose of objects does not initially derive from the ability to reason about mental purpose but from a more situation-based developmental precursor. Such a claim is interestingly related to proposals by Hatano and Inagaki, that children possess a non-intentional 'vitalistic' understanding of agency that is applied specifically to living things and underpins the first biological theory[4] (see Box 1). Furthermore, the idea that teleo–functional thought derives from Gergely and Csibra's 'principle of rational action' has several strengths. First, it appeals to intuitions that people can reason about both goal-directed behaviors and object purpose without attributing goals to any agent[3,48]. [For example, people seem able to discuss the goal of a bird's nest-building behavior (to make a shelter) or even the function of its nest

(to hold eggs), without seeming to consider the bird's intentions at all]. Second, Gergely and Csibra's proposal appeals to desires for parsimony, as reasoning about goals and functions can be attributed to infants without richly characterizing their representational capacities.

However, these strengths are worthy of further scrutiny. First, with respect to the origin of teleological–functional intuitions, it is true that an assertion of function, such as a 'a vacuum-cleaner is for sucking up dirt', involves no overt reference to any agent, whether it is a designer, beneficiary or user. This does not negate the fact that, in the case of artifacts, and potentially other object types too, a grasp of agency seems prerequisite to any meaningful understanding of function. Objects such as refrigerators only possess functions because they have been designed with the intention of being used to benefit some agent in a particular way. Arguably then, when considering artifacts, a conception of function is built upon the ability to ascribe goals either to an object designer or, at the very least, to an object user – the agent who typically interprets and actualizes the intentions of the designer (see also Refs 49,50). This argument can also be extended to natural objects, for despite claims that teleological statements such as 'hearts are for pumping blood' are scientifically permissible because they do not necessitate attributions of agency (either to the heart or to a putative intentional designer)[51–52], centuries of animist, deist and theist thought suggest that this type of non-intention-based construal is not psychologically natural to people[53–56]. This point is underlined by the finding that, when people are encouraged to use the mechanism of natural selection as an alternative to intentional accounts of natural function, they habitually distort the theory into a quasi-intentional form, wherein goals and designs are attributed either to nature or to the natural objects themselves[57–59].

With respect to the second strength of parsimony, it is true that Gergely and Csibra's view on the origin of theory of mind abilities presents a 'lean' account of an important early competence. Whether this is a cautious account is open to debate. The idea that infants bootstrap from an innate view that goals exist in the world to understanding that they exist in agent's heads, involves crediting them with rather substantial inferential machinery. From a learning perspective, there are also questions about what experiences could constitute the counter evidence that would cause a highly predictive, rationality-based construal of goal-directed action to undergo a conceptual change into an intentional form.

Conclusion

In this article, some questions have been raised concerning the topic of teleological thought and its relationship to a number of current debates within the field of cognitive development. To summarize, recent research indicates that children and adults both possess a teleological–functional construal of artifacts and biological properties. However, while these similarities exist, young children and adults also differ in ways that could present challenges to claims that teleological–functional thought forms the basis to an early autonomous biology. Specifically, young children promiscuously assert that entities of all types, including non-living natural objects, are 'made for something'. It remains an unanswered question whether this systematic teleological bias operates purely at the level of explanation – manifesting itself only when children lack answers – or whether it more deeply affects children's everyday interactions with objects and events in the world[23]. Current work is exploring this issue while also focusing on ways to differentiate several hypotheses regarding the origins of teleological–functional intuitions. These include proposals that the teleological stance is innate[2,13–15], that it emerges from an understanding of intentions and artifacts[21–23] and that it derives from a non-mentalistic precursor to theory of mind[3,33,47]. The resolution of the question of origins will not only provide insights into the early structure of the mind but potentially also has implications for educational practice. Young children's biology education routinely focuses on rote knowledge of the teleological mappings between body parts and their functions ('lungs are for breathing' etc.) Children are therefore actively encouraged to view animal parts in teleological terms without qualification or explanation of the natural mechanisms underlying biological function. If it is the case that young children's teleological–functional understanding is embedded in the intentional domain, such an unchallenged emphasis on structure–function mappings might ultimately act as an impediment to children's development of a truly autonomous biological explanatory system. It might also impact on their future understanding of biological adaptation as a process that occurs by virtue of a blind, non-intentional selection mechanism.

It is my hope that this brief introduction will highlight the relevance of this topic to various questions within cognitive science, motivating research that will move us towards a deeper understanding of why people seem so fundamentally compelled to ask 'why?' and 'what's that for?'

Outstanding questions

- What kinds of input do adults provide to children that might promote the development of a teleological bias?
- Western-educated adults tend to restrict their teleological explanations to artifacts and biological traits? How does the acquisition of scientific concepts interact with the propensity to think about the natural world in teleological terms?
- What can cross-cultural and cross-species comparisons reveal about the relationship between teleological thought, language and other types of reasoning?
- Young children promiscuously state that objects of all types are 'made for something', but are certain types of object properties more likely to provoke teleological thought than others? Recently, it has been argued that children's 'theory of biology' might simply reduce to a knowledge of mechanical causality[60]. What role might children's intuitive physics and mechanics have in the development of teleological–functional reasoning?
- Are 'theory-of-mind' deficits found in autistic individuals sufficiently profound that they affect the basic ability to attribute intentional goals to agents? If they are, might autism provide insight into the origins of both teleological–functional thought and intuitive biology?

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