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Teleological reasoning about nature: intentional design or relational perspectives?

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According to the theory of ‘promiscuous teleology’, humans are naturally biased to (mistakenly) construe natural kinds as if they (like artifacts) were intentionally designed ‘for a purpose’. However, this theory introduces two paradoxes. First, if infants readily distinguish natural kinds from artifacts, as evidence suggests, why do school-aged children erroneously conflate this distinction? Second, if Western scientific education is required to overcome promiscuous teleological reasoning, how can one account for the ecological expertise of non-Western educated, indigenous people? Here, we develop an alternative ‘relational-deictic’ interpretation, proposing that the teleological stance may not index a deep-rooted belief that nature was designed for a purpose, but instead may reflect an appreciation of the perspectival relations among living things and their environments.

Are clouds ‘for’ raining?

The past decade has seen a surge of research focused on how people reason about the natural and man-made world across cultures and development. Much of this work has focused on ‘teleological reasoning’ (see [Glossary](#)), the signature of which is an appeal to function or purpose (e.g., ‘clouds are for raining’). What kinds of concepts and intuitive beliefs undergird such statements?

The influential theory of ‘promiscuous teleology’ holds that teleological thinking reflects inaccurate causal reasoning about natural kinds as intentionally designed for a purpose. In this article, we develop an alternative perspective. Building on insights from research on conceptual development and indigenous ecological reasoning, we propose that teleological thinking about nature reflects relational reasoning about perspectival relations among living things and their environments. We outline major points of difference between these two accounts of teleological reasoning and offer evidence in support of a ‘relational-deictic’ framework. Finally, we discuss how the relational-deictic interpretation offers a new perspective on the role of teleological thinking in conceptual development and cultural cognition.

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‘Promiscuous teleology’: the intentional design stance

According to the theory of ‘promiscuous teleology’ (PT) [1–5], statements such as ‘clouds are for raining’ reflect a deep-rooted belief that natural kinds are intentionally designed for a purpose. Although such reasoning is appropriate for certain domains (e.g., artifacts), it is considered promiscuous when extended to natural kinds because it implies ‘agentive and intentional conceptualizations of Nature’, where physical-causal mechanistic explanations would be superior ([2], p. 8). To get a flavor for this kind of thinking, consider a standard teleological task ([2–5]; example adapted from [5]). Participants are introduced to a pair of related entities (e.g., rainclouds, an animal) and asked why a particular relation between these entities exists (e.g., why there are many rainclouds in the animal’s habitat). In most tasks, participants are asked to choose between physical-causal explanations focused on the cloud’s existence (‘Because cold and warm air rubbed together in the sky’) and teleo-functional explanations focused on a self-serving or other-serving function, such as the needs of the animal (‘To give the animal water to

Glossary

Agency: the cause or initiator of an event. When the function of an entity is viewed as a property of agency (e.g., someone made clouds for raining), then teleological statements may point to a causal explanation reflecting an agentic design stance.

Deictic function: functions that point toward a sense of purpose arising from distinct ‘point(s) of view’ within a relational system of interdependencies (animals that need rain).

Intuitive theism: the idea that people are naturally biased to view nature as though it is intentionally created.

Patiency: the condition of being acted upon. When the function of an entity is viewed as a property of patiency (e.g., someone perceives clouds as for raining), then teleological statements may point to a relational explanation reflecting a perspectival stance.

Promiscuous teleology (PT): the theory that teleological reasoning about nature reflects a tacit belief that natural kinds exist for a purpose, akin to an artifact-like design stance, where purpose is intrinsic to one entity (either a designer or the entity itself). Such reasoning is considered to reflect erroneous causal explanations invoking agentive, intentional conceptions of nature when physical-causal mechanistic explanations would be superior.

Relational function: functions that are a property of the relationship between at least two entities and, as such, are extrinsic to the individual entities. Such functions may be characterized by various kinds of relationships, including dependencies, affordances, habitats, helping or hurting relations, or others.

Teleological reasoning: reasoning about entities or events by appeal to function or purpose. Teleological reasoning includes formulations such as, ‘X helps there be more Y’; ‘It is better for X to have Y’; or ‘X exists so that/for Y’ [57].

live'). In others, participants are simply asked to judge the accuracy of teleo-functional explanations [2,6].

Performance on these tasks reveals a clear developmental pattern. Two factors are considered central to this shift: developmental time and exposure to Western science. Primary-school-aged children (and adults with little Western schooling) tend to endorse statements such as 'rainclouds are for giving animals water' [3,7]. This is interpreted as evidence that young children and non-Western adults mistakenly believe that natural kinds, like artifacts, were designed to 'exist for a purpose'. On the PT view, this belief is eventually replaced, in Western-educated older children and adults, with a more mature understanding that artifacts (but not natural kinds) are designed for a purpose [2–5]. The theory of PT, which also underlies the claim that people are 'intuitive theists' ('...naturally biased to view nature as though it is intentionally created', [8], p. 77), has resonated throughout the cognitive sciences, influencing interpretations of concept development [9–13] science learning [8,14], religion and morality [15–20], and cross-cultural reasoning [7].

One strong advantage of the PT theory is that it elegantly synthesizes a range of evidence. However, a full consideration of PT raises two paradoxes. The first is developmental: there is considerable evidence that infants spontaneously distinguish animate beings from artifacts [21,22] and that young children reason precociously about animates and other natural kinds, as compared to artifacts [23,24]. Why, then, would children conflate animate beings with artifacts when it comes to reasoning about purpose? The second paradox is cultural: there is considerable evidence that indigenous individuals are expert in reasoning about the natural world [25–28]. Yet PT asserts that teleological misunderstandings and 'unwarranted' beliefs about the natural world persist among non-Western educated adults [7]. Why would indigenous people, whose ecological expertise surpasses that of most Western educated adults [28–30], remain unclear about causal relations underlying natural phenomena?

An alternative interpretation: the relational-deictic framework

To resolve these paradoxes, we propose an alternative framework for 'promiscuous' teleological reasoning about nature that highlights the contribution of relational and ecological reasoning across development and cultural communities [25–33] and aligns well with recent research on contextual, relational cognition [34–39]. Because discussions of teleological reasoning [23,40–42] have not yet engaged this relational dimension, the conceptual distinctions articulated here are new (Table 1). To begin, notice that 'promiscuous' teleological functions are inherently relational: they engage reasoning about at least two entities (e.g., animal, rainclouds). They are also inherently deictic: they mark 'points of view' within a relation. We therefore propose that teleological reasoning about natural phenomena indexes relational and deictic dependencies, rather than theistic, intentional functions.

From this vantage point, reasoning patterns that until now have been interpreted as promiscuously teleological may instead reflect an appreciation of the relations among

entities in the natural world. We focus on functional properties that are considered 'promiscuous' in current accounts by virtue of their appeal to factors other than those intrinsic to the target entity itself. Some self-serving functional explanations are neither relational nor necessarily incorrect (e.g., 'Trees exist to grow tall'). The relational-deictic framework differs from PT's intentional design stance along several key dimensions, outlined in Table 1. Here, we consider each of these dimensions in turn.

What reasoning frameworks are at stake?

According to PT, teleological reasoning about nature is flawed because it reflects erroneous causal reasoning. The statement 'clouds are for raining' implies that the functional consequence of one entity is also its own cause in 'backward causal fashion' ([2], p. 1). In our view, teleological statements need not be fundamentally about a single entity and its cause, but may instead represent reasoning about relationships among entities.

Statements such as 'clouds are for raining,' need not index a commitment to an intrinsic function (rain) that arises from a single source that is external to the relation, deriving either from the intentions of an extrinsic designer or an 'animistic agency' immanent in the entity itself [8]. Instead, such statements may point toward a sense of purpose arising from distinct point(s) of view within a relational system of interdependencies (needing rain); purpose is a property of that relation.

What conceptual representations are at stake?

Consider a pine tree, a jay bird, and the California mountains. Do pine trees grow in these mountains because they are homes for birds? One's answers to this question will depend upon which set of conceptual stances one favors. Endorsing a Western-science, 'non-teleological' response favors reasoning about individuals (rather than relations), adopting a single perspective (rather than many), and identifying 'purpose' as a property of agency (rather than patiency). In the following examples, the first conceptual stance yields correct answers by PT accounts, but the second offers a plausible, ecologically-rich notion of purpose.

Individuals over relational systems In the tree-bird pair, different conceptual units are possible. If focusing on individuals (or individual kinds), one will focus on properties intrinsic to each kind (determined perhaps by internal essence), independent of context. Reasoning in this manner, one might conclude that California pine trees do not grow there because they are homes for birds by pointing out, 'Trees grow from tree seeds.' If focusing on relations, however, one will attend to systems, treating otherwise distinct kinds (bird; tree) as a relational unit ('HOME FOR') yielding many possible relations (functional, ecological, social, contextual). Such responses will appeal to relationships: 'Yes, birds make their homes in pine trees, protect the trees by eating harmful insects, and help them reproduce by dispersing pine seeds.' By definition, relations are *extrinsic* to individual entities [35]; purpose is intrinsic to the relation rather than to any one entity (either designer or object).

Table 1. Key distinctions between two accounts of teleological reasoning about nature

	Promiscuous Teleology: Intentional Design Stance	Alternative View: Relational-Deictic Stance
1. Frameworks of reasoning: What are the intuitive beliefs at stake in teleological statements?		
Summary	Teleological reasoning indexes intentional design (designed for a purpose); function is context independent and intrinsic to the entity (via designer)	Teleological reasoning indexes relationships and point of view (perceived as purpose); functions are context dependent and intrinsic to relationships
2. Conceptual Stances: What are the conceptual representations at stake in teleological tasks?		
Conceptual Unit	Focus on individual entities as the conceptual unit (TREE; BIRD); decontextualized, intrinsic properties	Focus on relational system as conceptual unit ('HOME FOR'); contextualized, emergent properties
Perspectives	Assumes objective perspective on 'the purpose/function' (Tree is FOR x)	Assumes subjective perspectives from which purpose(s) emerge (Tree is FOR x, y, z, depending on point of view)
Agency/Patency	Purpose arises from intentional agency (designed for a purpose)	Purpose arises from perceived (inter)dependency (perceived as having a purpose/function)
3. Predictions: What does each view predict as concomitants of a teleological stance?		
Prediction 1	Purpose as intrinsic property of entity; 1) predicts context-independent appraisals of function (designed FOR x)	Purpose as property of relationship; 1) predicts contextualized appraisals of function (perceived as FOR x, y, or z, depending on point of view)
Prediction 2	Purpose arises from designer ('inference to design')	Purpose arises from perceiver's <i>sense of purpose</i>
Prediction 3	Purpose/function has single source: either extrinsic designing agent ('theistic'), or immanent in function-serving entity itself ('animistic')	Purpose/function has multiple sources: points of view of entities engaged in relational system(s)

Single objective perspective over multiple perspectives
In the tree-bird pair, different perspectives can be adopted. From a single objective perspective, one may conclude that (essentially) trees are not 'for' anything. This line of thought would support a negative response that transcends particular ecological relationships to conclude that 'ultimately, trees just exist.' From a multiple perspectives approach, however, one may consider the tree-bird relation from several points of view, allowing for plural purposes embedded in ecological contexts. One might reason accordingly: 'well, if you are a bird, trees are for providing homes, food, or shade.' Indeed, judgments of concept properties are sensitive to situated interactions and contexts, making this kind of reasoning quite natural [36,37].

Purpose is a property of agency rather than patency
If purpose is assigned to intentional agents, then teleological statements may be seen as invoking an agentic design stance. From this perspective, one might reject the idea that trees are for bird homes by reasoning that 'if a tree is for anything, then it must have been designed for that purpose, and I do not think anyone designed trees.' However, if purpose arises from perceptions of patency (often via interdependency), then teleological statements may be seen as invoking a subjective point of view. From this perspective, one might suggest that trees are for bird homes 'in the sense that birds perceive trees as nesting places.'

Interestingly, the teleological statements provided above are ecologically accurate when viewed as perspectival reasoning about a system of relationships. Birds protect pine trees by reducing insect pest populations and are vital to pine reproduction through seed dispersal; recent out-migration of birds is leading to localized pine deaths in California (NBC Learn and NSF 2012, 'Disappearing lizards: Changing planet'), as well as around

fracking facilities [43]. In places where birds have abandoned their arboreal residency, pine trees do not grow well.

Predictions of the relational-deictic framework

A relational-deictic framework presents three testable claims regarding the conceptual representations that underlie teleological reasoning about nature. If teleological statements are grounded in relations, then (i) purposes should be seen as plural, context-dependent properties of relations rather than as intrinsic properties of individual entities. It should be noted that current PT accounts are unclear as to whether individuals should be willing to simultaneously endorse multiple teleological functions for a single natural kind. We suggest that such response patterns would imply awareness that multiple entities can perceive multiple purposes emergent from relational affordances, rather than multiple purposes intended through design.

Participants should tend to construe teleological purposes as (ii) emergent from points of view (iii) within a relational system, independently of whether they invoke an intentional designer external to that system. These predictions are consistent with extant evidence (Box 1).

Resolving the paradoxes of culture and development

The relational-deictic interpretation raises the possibility that reasoning frameworks are influenced by culture and schooling. This offers novel explanations for previous evidence. Consider, for example, how cultural systems vary in their emphasis on individuals and relations. Although Westerners tend to favor taxonomic groupings and to focus on individuated entities isolated from context, non-Westerners tend to group objects in a relational-contextual manner ('mothers take care of babies and go together') and to focus on holistic systems of entities embedded in

Box 1. Existing evidence for the relational-deictic framework

Converging developmental and cross-cultural evidence for relational reasoning

Research reveals that both adults from Korea and 3- to 5-year-old children from the USA are less likely to use category membership than other relations when reasoning about novel properties of animals [45,58]. For adults, this pattern has been interpreted as evidence that Easterners rely less than Westerners on category knowledge. However, for preschoolers, this same pattern has been interpreted differently: their tendency to invoke non-categorical relations has been assumed to reflect a 'teleo-functional constraint on reasoning about animal behavior', one that likely derives from a default 'design assumption', in which biological structures are assumed to be designed for functions [58, p. 341]. We propose a more parsimonious interpretation of this pattern: both children and Korean adults appeal more to relations than do Western adults (see below).

What counts as a function varies with the particular relation involved and the point of view adopted

Preschool children's explanations [58] reveal their sensitivity to relations and to distinct perspectives within a relation. For example, when asked 'Why do birds go up in trees?', children refer to several different relations from a bird's point of view ([58], p. 335):

'So (it) can find birds and build (a) nest' (social, habitat)

'So he can eat insects' (feeding)

'So it can feed its birds' (family)

'Because they love living there' (habitat, explicit perspective-taking)

Interestingly, although relational-perspectival justifications were invoked at precisely the same rate as 'function-based justifications', only the latter were singled out and these were interpreted as evidence that children 'view animals as 'quasi-artifacts' whose properties, like those of clocks and cars, have been somehow purposefully created to perform particular activities' ([58], p. 341). We suggest that when the full range of children's responses is considered, their appeal to relations and perspective-taking becomes clear.

Teleological statements do not require a designer

In an intriguing line of work, Lombrozo *et al.* [6] hypothesized that individuals with impaired causal reasoning may provide a window into intuitive biases. They predicted that Alzheimer's patients would be more likely than healthy peers to endorse promiscuously teleological statements. Although this prediction held up, these patients were no more likely than peers to invoke an intentional creator [6]. This is consistent with our assertion that teleological statements do not necessarily signify a commitment to an intentional creator.

context [27,31,44–47]. Relational approaches may support teleological responses precisely because they highlight ecological affordances and relations. Moreover, recent evidence reveals that in indigenous communities, it is common practice for children and adults to adopt the perspective of nonhuman entities [33]. This likely supports attention to deictic purposes.

Of particular interest is the possibility that one's proclivity for adopting either an intentional-design or relational-deictic stance is tied to one's cultural frameworks of nature. Western schooling supports a tendency to abstract individual entities away from their context, to focus on taxonomic relations, and to assume a distal, 'objective' point of view on nature [45,48–50]. Because children are sensitive to context and task demands [35,51,52], it is reasonable to assume that these norms (and children's expectations about 'right' answers) may underlie the developmental shift in which promiscuous teleological

responses decrease with age and Western schooling [7]. However, recent research with indigenous communities indicates that this 'shift' may be a product of Western culture. Many native communities privilege relational frameworks that direct attention to multiple perspectives ('all living things have their own point of view'), interconnectedness, and (causal) interdependency ('all things have a role to play'), [27,29,30,33,53–56]. Frameworks like these support sophisticated ecological reasoning which – unsurprisingly, given the emphasis on perspectives and relations – exhibit parallels with 'promiscuous' teleological reasoning. For example, Itza' Maya readily acknowledge plant-animal helping-hurting relationships ('Animals help plants to grow by dispersing seeds') [25]; and Menominee children and adults frequently reason about ecological relations by taking multiple perspectives ('Porcupines may kill trees by stripping bark, but help the forest by allowing light to reach the forest floor') [32,33]. Such statements may seem 'unwarrantedly' teleological when considered in isolation [57]; but in context, they are ecologically accurate statements about complex relationships viewed from multiple perspectives.

The apparent developmental and cross-cultural paradoxes raised by PT may be resolved if one adopts a relational-deictic framework. From this vantage point, it is not that young children confuse natural kinds with artifacts, but rather that they view natural kinds as living in relationships that afford multiple perceived purposes. On this view, children who are schooled in a Western framework offer fewer promiscuously teleological responses because they have learned to favor taxonomic and objective criteria, rather than ecological and relational stances. Thus, a shift away from promiscuously teleological thinking may reflect Western-educated children's and adults' exposure to a particular worldview. Non-Western adults' endorsement of teleological statements likely reflects their commitment to viewing natural kinds as 'living in relation' amid webs of interdependency (Box 2).

Concluding remarks

Does 'promiscuous' teleological reasoning index a deep-rooted belief that natural kinds were intentionally created for a purpose [1–5,15]? We have suggested a new relational-deictic framework that takes into account a rich set of relations and perspectives among natural entities, that permits one to avoid cultural assumptions about the 'right way' to conceptualize nature, and that identifies the claim for 'intuitive theism' as a culturally-infused stance. Kelemen writes that teleological reasoning is a 'side-effect' of people's natural inclination to 'privilege intentional explanation' and view 'nature as an intentionally designed artifact' ([15], p. 296). The relational-deictic framework outlined here offers a different interpretation: teleological reasoning reflects a tendency to think through perspectival relationships within (socio-ecological) webs of interdependency. On this view, the origins of teleological thinking are social and relational rather than individual and intentional. This has implications for ongoing debates about the primacy of social and relational theories in human development [34,38,39].

Box 2. Why do experts hold 'scientifically unwarranted teleological intuitions'?

Distinct cultural frameworks influence the way we reason about nature [27,31–33]. The relational-deictic approach helps to explain reports of 'promiscuously' teleological reasoning among experts in a variety of settings.

Non-Western experts

Based on evidence that Romani adults endorse more teleological statements than fourth-grade children in the USA, PT theorists proposed that non-Western educated adults hold 'scientifically unwarranted teleological intuitions' about nature. By contrast, research among indigenous communities has focused on 'relational epistemologies', frameworks that explicitly 'relate species to other aspects of nature', emphasize that each species has 'a role to play', and value perspective-taking of others ([27,33]; Ross *et al.*, unpublished manuscript). In relational epistemologies, all things exist in relation.

From a relational viewpoint, the question 'Why do trees exist?' may well be interpreted as 'Why do trees exist in relation?' Explanations focusing on relationships will naturally be more satisfying responses to this question, and teleological explanations tend to mark relational interactions among entities and their environments. On the other hand, alternative 'physical-causal' explanations focus on single

entities in isolation. From a relational point of view, such explanations approach tautology ('Why does Earth have trees?' 'Because they grow from tree seeds') ([6], p. 1001). It would be interesting to see whether response patterns change when relational causal explanations are offered ('Because animals, birds, and insects pollinate and disperse tree seeds'), a possibility we are currently investigating.

In sum, viewed from the lens of relational epistemology, a rock is 'for' scratching from the point of view of the animal at that point in time. This is not a 'scientifically unwarranted' intuition, but rather a description of a relation from a particular point of view.

Western experts

Although professional Western scientists deny believing in candidate designers such as God or 'Mother Earth', they nonetheless endorse 'scientifically incorrect' teleological statements at a rate of 15% ([2], on an unspeeded task). We propose that in endorsing such statements, which are not uncommonly found in scientific text (e.g., 'The Earth has an ozone layer in order to protect it from UV light' [59]), scientists have not reverted to an immature deign stance, but are instead appealing to a relational framework. Indeed, the fact that professional scientists endorse such statements at all calls into question the claim that they reflect 'promiscuous' misunderstandings.

Box 3. Competing views of nature

According to the theory of PT, the 'correct' framework for thinking about nature is one which appeals to physical-causal explanations of animal behavior and distinguishes these from social and intentional explanations ([58], p. 337). It is claimed that children must come to understand that 'mental states and personality characteristics are irrelevant to why an animal lives, eats, or defends itself in the way that it does' ([58], p. 342). Reference to animals' mental states is considered 'personification' and assumed to be a strategy adopted in the 'absence of knowledge' ([58], p. 337). However, biologists often take a different view in asserting that the biological capacities of animals are not divorced from their mental and social capacities [29].

In fact, biologists argue that both human and non-human animals inhabit complex social and mental worlds, and intra- and inter-species cooperative strategies are critical to mutual adaptation and survival [60–64]. Moreover, animals' participation in cooperative socio-ecological systems means that 'other-serving functions' aid own survival. Therefore, appeals to such functions may be neither immature nor unwarranted.

Similar socio-ecological, systems-like perspectives have long enjoyed priority in indigenous science [29,65]. Thus, there is a tension between a Western researcher's 'scientific' view of nature and those of various Indigenous communities. Such epistemological orientations cannot be ignored (or dismissed as 'animistic') when making claims about 'other' people's reasoning styles. Whereas by Western psychologists' standards nonhuman animals may be asocial and unthinking, indigenous people often see such entities as capable of relating with others [66,67]. What may be an 'unwarranted' statement in the eyes of a Western researcher may be a correct reading of ecological relationships in the eyes of an indigenous expert.

Lastly, cultural attitudes toward nature present another paradox for PT theory. If non-Western educated peoples incorrectly construe natural kinds as intentionally designed artifacts, they should be more likely than Western educated adults to treat natural kinds as resources to be exploited for human use. Instead, indigenous communities have developed a uniquely sustainable relationship with the rest of nature [30]. By contrast, Western industrial societies have developed more exploitative justification of natural 'resources' existing for human use [48].

The relational-deictic interpretation opens new avenues for research into how people come to understand the natural world and their place within it. Teleological reasoning may not be immature or misguided. Instead, it may reflect young children's ecological perspective-taking abilities and serve as an entry-point for reasoning about socio-ecological systems of living things, rather than reasoning about isolated, abstracted, and essentialized individual kinds [29,48] (Box 3).

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