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Seeing Cooperation or Competition: Ecological Interactions in Cultural Perspectives

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Abstract

Do cultural models facilitate particular ways of perceiving interactions in nature? We explore variability in folkecological principles of reasoning about interspecies interactions (specifically, competitive or cooperative). In two studies, Indigenous Panamanian Ngöbe and U.S. participants interpreted an illustrated, wordless nonfiction book about the hunting relationship between a coyote and badger. Across both studies, the majority of Ngöbe interpreted the hunting relationship as cooperative and the majority of U.S. participants as competitive. Study 2 showed that this pattern may reflect different beliefs about, and perhaps different awareness of, plausible interspecies interactions. Further probes suggest that these models of ecological interaction correlate with recognition of social agency (e.g., communication, morality) in nonhuman animals. We interpret our results in terms of cultural models of nature and nonhuman agency.

Keywords: Folkecology; Folkpsychology; Nonhuman agency concepts; Culture; Indigenous ecological knowledge

1. Introduction

Concepts of how organisms interact with each other and their environments form the foundation for understanding natural systems (White, 1997). How people interpret these interactions—as positive or negative, cooperative or competitive—is fundamental to their conceptualization of nature, and ethnographic surveys point to the centrality of such concepts to environmental knowledge and conservation (e.g., Anderson, 1996; Pierotti,

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2011). However, conceptions of species interactions remain underexplored in cognitive psychology, despite their pivotal role for understanding of human interactions with nature.

Folkecology refers to people's cognition of ecological relationships between plants, animals (including humans), and environments (Atran et al., 2002). Like other naïve conceptual knowledge systems, or folktheories, it encompasses unique causal principles that guide people's reasoning about entities and events in a particular domain (i.e., ecosystems). The current research focuses on two causal principles fundamental to ecological reasoning: cooperation and competition. The key question concerns the role of these interpretive principles in reasoning about species interactions across cultural groups.

Species interactions are the backbone of folkecological models, which serve to organize not only environmental knowledge but also values and practices. Cultural variation in folkecological models has demonstrable consequences for biodiversity and conservation (Atran et al., 1999, 2002; Medin, Ross, Cox, & Atran, 2007). Given the relevance of species interaction concepts to environmental decision making (Linnell & Strand, 2000; Markowitz, Slovic, Västfjäll, & Hodges, 2013), it is important to investigate potential cultural variation in such concepts (Kahan et al., 2012; Newell, McDonald, Brewer, & Hayes, 2014). In the present research, we compare reasoning about interspecies interactions across two cultural groups. Indigenous Panamanian Ngöbe and U.S. participants interpreted an illustrated nonfiction book about the hunting relationship between a coyote and badger. In two studies, we examine whether individuals from each group interpret this interaction differently, and if so, whether these interpretations correlate with distinct views of nonhuman animals.

2. Relationships between cooperation and competition and levels of analysis

So far we have used the terms "cooperation" and "competition" in an informal intuitive sense, but this entails considerable oversimplification. Consider a team sport like basketball. For a given team, individual players compete with each other to make the team and for playing time. And each team competes with other teams. But at this level of team competition, team success depends on individuals cooperating for both offense and defense. So within-team cooperation helps between-team competition. Even competing for playing time within a team may make fellow teammates better players and foster overall team success. In short, the relationship between cooperation versus competition at one level of analysis need not hold for all levels of analysis.

Now consider two species of predators who rely on the same prey resources. In this study, we use coyotes and badgers as predators and ground squirrels as their prey. One plausible assumption is that coyotes and badgers compete for squirrels at both the species level and at an individual level. Here, species competition emerges as the byproduct of individual badgers and individual coyotes competing for squirrels. But it is possible that local or individual *cooperation* of coyotes and badgers might foster better overall success in hunting prey. In this study, our focus is on cooperation versus competition at the level

of individuals. As we will see, ecological science suggests that coyotes and badgers do cooperate in hunting prey.

3. Competition as a principle of folkecological reasoning

As yet, the role of cooperative or competitive principles in folkecological reasoning is an open issue. In the expert ecological domain, by contrast, it is well documented that the Darwinian tradition often sees both individuals and species as competing to survive. Canonical models treat negative interactions (e.g., competition, predation) as the "building blocks" of ecosystems (e.g., Holt & Polis, 1997, p. 745), and competition is the default assumption in many relationships between species (Minta, Minta, & Lott, 1992; Palomares & Caro, 1999). Competition has been a productive framework for interpreting ecosystem dynamics, but its very robustness may have overshadowed the role of cooperation in ecological communities (Shouse, 2003). More recently, research has begun to highlight widespread positive interactions (e.g., cooperation, commensalism) in ecosystems (Bruno, Stachowicz, & Bertness, 2003).

One illuminating case study comes from interactions between intraguild predators (species that exploit the same resources), such as the North American carnivores coyote and badger. Intraguild predators are typically assumed to be competing for limited resources on the logic that any resource removed by one species (or by one individual) reduces the amount available to others. Consequently, standard models predict negative interactions between such predators (e.g., Linnell & Strand, 2000, p. 174; Palomares & Caro, 1999). But there is also evidence that intraguild predators may have positive relationships—as, in fact, coyotes and badgers do. The two hunt cooperatively by giving joint chase or trapping squirrels in tunnels, with the badger digging from below while the coyote waits at burrow exits (Kiliaan, Mamo, & Paquet, 1991; Minta et al., 1992). Both coyotes and badgers obtain more prey when hunting together than alone. Interestingly, their association also involves behaviors not directly related to hunting activities, including play, sustained nasal-nasal and body contact, and resting together.

The hunting relationship between individual coyotes and badgers is a clear case where competitive and cooperative interpretations afford divergent understandings of an interaction. As noted earlier, cooperation and competition do not necessarily constitute mutually exclusive or opposing views. A single ecological relationship may be seen as positive or negative depending on the level of analysis (e.g., individual, population, community), and even within levels, many relationships simultaneously involve aspects of both (Bruno et al., 2003; De Waal, 2000; Polis, Myers, & Holt, 1989).

3.1. Current research hypotheses

Conflict-oriented scientific models suggest a tendency to interpret interspecies interactions in terms of competition rather than (or before) cooperation. There are at least three

candidate explanations for why competition may be the most common lens for viewing such interactions:

1. *Competition may be a widespread default assumption*. A propensity for understanding interactions in terms of competition may be a widespread feature of folkecology. This would be consistent with evidence for cognitive universals in folkbiology, a closely related domain (Atran, 1998).
2. *Competition may be linked to expertise*. The assumption that interactions are generally competitive may develop (further) through ecological expertise in the form of domain knowledge about organisms, environments, and their interactions. Previous research shows that domain knowledge influences folkbiological inductive and causal reasoning (reviewed in Medin & Atran, 2004). Experts and laypersons may also reason differently when it comes to folkecological interactions.
3. *Competition may reflect a cultural bias*. Another possibility is that competitive interpretations reflect a cultural model. On this approach, cultural models are sets of (often implicit) assumptions that inform skeletal principles of reasoning (Medin, ojalehto, Marin, & Bang, 2013). They may interact with other bodies of explicit knowledge that also vary across groups (e.g., ecological expertise) but are distinct in that they reflect implicit strategies for organizing conceptual knowledge consistent with broader orientations to nature (see Bang, Medin, & Atran, 2007).

Given wide-ranging diversity between and within groups—both Western and Indigenous—one should be cautious in making categorical generalizations (Ramos, 2012). Some scholars suggest that despite spatial, physical, and ecological variation, "there appears to exist a fundamental shared way of thinking and a concept of community common to Indigenous people of North America" (Pierotti, 2011, p. 5). Our use of "Indigenous models" relies on converging cognitive and ethnographic findings across a number of Amerindian communities, which indicate an epistemological orientation to see humans as part of nature, to emphasize principles of interconnectedness ("everything has a role to play"), and to take the perspective of nonhumans (Medin et al., 2013). Still, "Indigenous" and "Western" represent very broad categories, and thus we adopt a suitably cautious stance by focusing on the more specific question of whether our Indigenous Panamanian Ngöbe and U.S. undergraduate samples differ in their interpretation of coyote–badger relationships. If we find cultural differences, their generality can be probed with additional samples and converging measures.

It has been suggested that the competitive slant in ecological theory is tied to Western scientists' cultural values (Todes, 2009). Research shows that Euro-Americans tend to adopt a competitive orientation to interpersonal interaction and behavioral attribution, as compared to other ethnicities and cultures (e.g., Cox, Lobel, & McLeod, 1991; Gelfand & Christakopoulou, 1999; Gelfand et al., 2001). Comparable research on perceptions of species interaction is scarce, but there is some evidence to suggest that U.S. individuals adopt a similarly competition-oriented view of human-animal relations (Markowitz et al., 2013). To the extent that a competitive ecological bias is tied to Western values, interactions between scientific and popular knowledge could reinforce

this cultural model. For instance, competition figures heavily in Western cultural representations of nature, including popular science media (e.g., National Geographic videos with titles such as "Predators at War" and "Relentless Enemies").[1] In short, culture may inform experts' perspectives just as science influences folktheories of nature (Medin & Bang, 2014), and both may relate to broader cultural values (e.g., economic competition) (Todes, 2009).

Although there is evidence suggesting cultural differences in the perception of "helping" (cooperative) versus "hurting" (competitive) interspecies relationships (Atran, Medin, & Ross, 2005; see also Medin et al., 2006), to our knowledge there have been no studies examining beliefs about interspecies cooperation at an individual, intentional level.

Ethnographic reports suggest divergence between Western and Amerindian views of competition (Anderson, 1996; Pierotti, 2011), but such claims are typically based on verbal reports and people's stated beliefs can diverge from their inferences about novel scenarios (Astuti, Solomon, & Carey, 2004). More direct evidence is needed to illuminate how people systematically apply folkecological principles in interpreting species interactions. The current research aims to address this gap, using the coyote–badger relationship at the individual level as a test case to probe the role of cooperative or competitive principles in folkecological reasoning.

3.2. Individual interspecies interactions and folkpsychology

The coyote–badger relationship involves individual-level social interaction between two animals (Minta et al., 1992),[2] as distinct from population-level species interactions studied in previous folkecological research. These two kinds of interaction could recruit distinct forms of naïve reasoning. Laypersons may explain population-level cooperation in terms of ultimate evolutionary mechanisms (e.g., coevolution, kin selection), where mutual benefits accrue to both parties without explicit coordination (e.g., seed-dispersing birds and plants). In contrast, laypersons may believe that individual-level coordinated cooperation demands proximate social or psychological mechanisms (e.g., communication, social norms, decision making)—factors that also figure in scientific debate about animal cooperation (Stevens & Hauser, 2004).[3]

If so, then naïve reasoning about individual-level interspecies interactions may hinge in part on people's beliefs about animals' psychological capacities. This points to another potential route of cultural influence on a competitive bias. In previous work, we have documented that Ngöbe attribute sophisticated psychological capacities to animals (ojalehto et al., 2015), consistent with anthropological investigations documenting beliefs about nonhuman personhood among Amerindian communities (Harvey, 2005; Viveiros de Castro, 1998). In comparison, we found that U.S. individuals are less likely to ascribe human-like intelligence to animals, which resonates with related research among Western samples (Bastian, Loughnan, Haslam, & Radke, 2012; Gray, Gray, & Wegner, 2007). The current studies explore beliefs about animal psychology in an effort to better understand folkecological reasoning about individual-level species interactions.

4. Current research

Are competitive principles the uniform "building blocks" of intuitive folkecology, or is a focus on competition tied to expertise or culture? In the current studies, Ngöbe and U.S. participants interpreted a nonfiction picture story depicting the coyote–badger hunting association and reasoned about several aspects of this relationship. We expected this particular interspecies interaction to be novel for both groups, either due to unfamiliarity with these species (Ngöbe participants) or to general lack of ecological knowledge (U.S. participants). Novel scenarios presumably elicit inferences based on conceptual knowledge rather than simple fact retrieval, allowing us to investigate the interpretive principles privileged in different folkecological frameworks.

The key question was whether this ambiguous relationship would be interpreted as competitive or not. We built on the general competitive orientation in Western ecological theory to triangulate the relative contributions of expertise and culture to this stance. In contrast to ecologically naive U.S. undergraduates, Ngöbe informants share certain forms of expertise with Western ecologists (discussed below), whereas U.S. undergraduates share a Western cultural orientation with ecologists, in contrast to Ngöbe participants.

If a competitive orientation is a default, then both Ngöbe and U.S. participants should prefer competitive accounts of the coyote–badger relationship. If it emerges primarily through expertise (i.e., represents a discovery about how species relations work), then Ngöbe but not U.S. participants should prefer competitive accounts. Finally, if the competitive frame is cultural, then United States but not Ngöbe participants should prefer competitive interpretations.

In addition, we probed other conceptual frameworks that may tie into reasoning about cooperative interactions, including beliefs about animals' psychological and social capacities.

5. Study 1

5.1. Methods

5.1.1. Participants and populations

Participants were 12 Ngöbe adults (4 female) living in the research community described below and 11 U.S. undergraduates (4 female) attending Northwestern.

5.1.1.1. Ngöbe sample: Ngöbe participants' ages ranged from 19 to 63 years (M = 33.42, SD = 12.68). Participants were recruited through household visits or community meetings. Community permission and individual informed consent were received. Participants received a small compensation and a donation was made to the community fund.

The Ngöbe people have resided for millennia in what is now Panama (Gjording, 1991; Young & Bort, 1999). The primary research community of about 600 people is located on a forested coastal island. Lifestyles are closely coordinated with the surrounding ecology, and most community members largely subsist off the land and sea through agroforestry, fishing, and diving. Consequently, Ngöbe individuals interact closely with plants and animals and can be expected to expertly appraise the dynamics of animal interactions (Gordon, 1982).

The specific relationship between coyotes and badgers was novel to Ngöbe participants. Living on a Caribbean island, Ngöbe participants are unfamiliar with these North American species and most participants could not name the animals depicted.[4] Even so, they can be considered "experts" concerning ecological interactions more broadly.

5.1.1.2. U.S. sample: U.S. participants' ages ranged from 18 to 21 years (M = 19.45, SD = 1.21). Participants completed informed consent and received partial course credit for participating. The U.S. students came from predominantly upper-middle class backgrounds (60%); and students identified as Caucasian (57%), Asian/Asian-American (22%), Black/African-American (7%), Latino/Latina (3%), or other (12%).

Previous research has documented that U.S. undergraduates have impoverished experience with and knowledge about the living world, consistent with wider folkbiological knowledge devolution in Western industrial societies (Atran & Medin, 2008). Given this lack of domain-specific ecological knowledge, we expected that U.S. students would be unaware of the relationship between coyotes and badgers, even if they could name these animals (as less than half our participants could).

5.1.2. Materials and procedure

As part of a larger interview (administered for both groups), participants viewed an illustrated nonfiction children's book depicting the cooperative hunting relationship between a coyote and badger (Hiscock, 2001). The text was removed so the story could be interpreted only through the illustrations (see Fig. 1). The story follows first the coyote and then the badger (with two cubs) as each hunts small prey individually. After the two encounter one another nose-to-nose, they hunt together by trapping ground squirrels in tunnels and cornering a rabbit in a cave. Finally, they go their separate ways.

Participants first reviewed the entire book silently, and then narrated the story page by page. Participants were asked to describe what they thought was happening. All participants but one (United States) provided a realistic narrative; the fanciful narrative was excluded from analysis. Two Ngöbe participants told the story jointly, so there were a total of 11 Ngöbe narratives.

Participants were interviewed in Spanish by a Ngöbe co-author (S.G.G.) and the first author (Panama) or in English by two research assistants (United States) (see Appendix A for bilingual instructions). Ngöbe participants were bilingual in Spanish and their native Ngöbere; U.S. participants were fluent English speakers. Narratives were audio-recorded, transcribed, and translated into English (for Spanish).

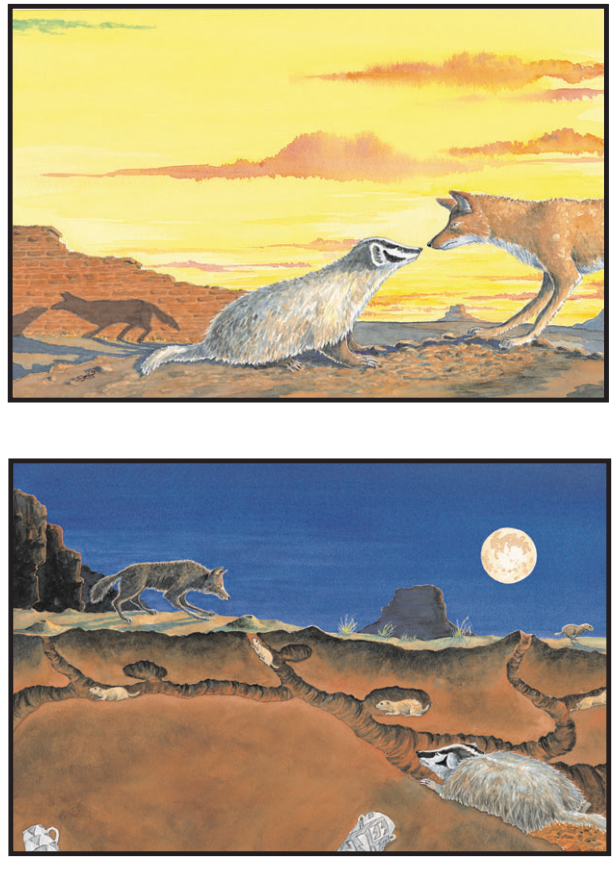

Fig. 1. Illustrations from storybook (images courtesy of Bruce Hiscock). Scene A: The coyote and badger encounter one another for the first time. Scene B: The coyote and badger hunt ground squirrels together.

5.2. Narrative coding

5.2.1. Categories of interaction

Each narrative was judged for its interpretation of the coyote–badger relationship. Indicators of cooperation or competition were derived from criteria used by ecologists to determine coyote–badger cooperation, which include hunting styles (e.g., apparent joint intent to hunt together), activity patterns (e.g., turn-taking in the hunt), and social interactions (e.g., sustained proximity, play) (Minta et al., 1992). Drawing on these indicators, we defined four mutually exclusive coding categories (see Table 1):

1. *Cooperative narratives* described the coyote and badger conveying joint intentions to hunt, coordinating hunting actions, and/or becoming friends or partners.
2. *Competitive narratives* described the two animals competing for prey, preying upon one another, and/or fighting.

3. *Split narratives* described the two animals competing and cooperating at different times.
4. *Neutral narratives* were ambiguous with respect to the relationship between the coyote and badger.

5.2.2. Psychological and social construals

Story narratives were coded for psychological and social construals of animals. Each narrative was coded for frequency of references to the following elements:

1. Psychological construals
   a. *Mental states* included cognitive (*think*, *hope*, *smart*), emotional (*sad*, *happy*, *brave*), or intentional (*try*, *want*, *stubborn*) states and traits.
   b. *Decision making* referred to discernment, planning, or deciding (*realize*, *plan*, *decide; make an agreement*).
2. Social construals
   a. *Communication* was coded according to form of exchange and information content as follows[5]:
      i. *Intentional communication* referred to meaning-based exchanges, including references to animals communicating in a human-like fashion (*conversing*, *visiting*,

Table 1
Coding examples for interpretation of the coyote–badger relationship

	Indicators of Relationship		
Interaction Type	Hunting Intent	Activity Descriptions	Social Interaction
Cooperative	"*A union. . .they made like an agreement to see how they could trap*." (*Ngöbe*)*	"*Badger scares rabbits from their places and the wolf is there ready to catch them*." *(United States)*	"*And now they find themselves good friends*." (*Ngöbe*)*
Competitive	*"The badger confronts him because he's on his territory." (United States)*	*"You see them fighting for the same food." (United States)*	"*[Badger] faces him and warns him not to dare touch his children*." (*United States*)
Split Narratives	*"Badger realizes that the wolf is taking all the food for himself and badger's not getting any." (United States)*	*[Mixture of actions from above two categories]*	"*The wolf isn't being very helpful*." *(United States)*
Neutral	"*They just have a stand off and stare at each other for a little while, and decide to move on*." *(Unites States)*	"*They're both walking around and happen to be at the same rock*." *(United States)*	*[No examples]*

Note. *See Appendix B for original Spanish narrative excerpts.

asking), expressing specific meanings (*she warned coyote not to come near her babies*), or engaging in dialogue ("*Where is the prey?*").

ii. *Signaling* referred to affect-based signs, including references to cues through body language (*facing off*, *stand-off*), eye contact (*recognize each other*, *give each other a death stare*), or other expressive channels (*howling*, *crying*).

b. *Affinity* referred to affiliative social dimensions of the relationship, including positive (*friends*, *helping*) and negative (*lonely*, *separated*) states.

5.3. Results

All participants provided a complete page-by-page book narrative. Total narrative word length differed across groups, with Ngöbe narratives longer (M = 538 words; SD = 233) than U.S. narratives (M = 366; SD = 103), $t(19) = 2.15$, $p < .05$. This was due to additional contextual details frequently present in Ngöbe narratives (e.g., descriptions of the environment). When only those utterances relevant to animal interactions were included (defined as sentences that had animate subjects or objects), this "focal" narrative length was similar across groups (Ngöbe: M = 340, SD = 180; United States: M = 328, SD = 106), $t(19) = 0.19$, *ns*.

5.3.1. Interpretations of interaction

5.3.1.1. Coding reliability: Two independent coders judged all story narratives for the interpretation of the coyote–badger interaction. Inter-rater reliability was high ($\kappa = 0.80$, $p < .001$; percent agreement = 86%).

5.3.1.2. Results: As shown in Table 2, Ngöbe usually interpreted the coyote–badger relationship as cooperative and U.S. participants as competitive. The majority (7/11) of Ngöbe saw cooperation, versus 2/10 of U.S. participants. In contrast, the majority (6/10) of U.S. participants saw competition, versus 0 Ngöbe participants. One Ngöbe and one U.S. participant gave a split narrative; the remaining narratives were neutral (3 Ngöbe, 1 United States). A chi-square test on the 2 × 4 (culture × interpretation) table indicated that the cultural difference in interpretations was statistically significant, $\chi^2(3, N = 21) = 9.75$, exact, 2-sided $p < .05$.[6] To test our key question, a 2 × 2 chi-square analysis was run using cooperative and competitive narratives only (excluding split and neutral narratives). We report the $N-1$ chi-square test rather than Pearson's chi-square, because the $N-1$ is more robust to low expected counts (Campbell, 2007).[7] This revealed a reliable cultural difference, $\chi^2(1, N = 15) = 8.17$, $p < .01$.

5.3.2. Psychological and social construals

5.3.2.1. Coding reliability: The first author coded all narratives, and an independent rater coded a third of the narratives (n = 7) for psychological and social terms. Inter-rater reliability was assessed using the intra-class correlation (ICC) for continuous data. ICCs were high for each coding category, ranging from ICC = .92 (df = 6), $p < .01$, to ICC = 1 (df = 6), indicating excellent agreement.

Table 2
Interpretations of the coyote–badger relationship in narratives, Study 1

Culture	Competition	Cooperation	Neutral	Split Narrative
United States	6 (60%)	2 (20%)	1 (10%)	1 (10%)
Ngöbe	0 (0%)	7 (64%)	3 (27%)	1 (9%)

5.3.2.2. Results: Social and psychological construals were analyzed by culture using MANOVA. The dependent measure was the average frequency of codes per 100 words based on focal narrative length.

5.3.2.3. Psychological construals: No cultural differences were found for reference to mental states (Ngöbe: $M = 1.72$, $SD = 1.38$; United States: $M = 1.68$, $SD = 1.31$), $t(19) = 0.07$, ns, or decision making (Ngöbe: $M = 0.54$, $SD = 0.41$; United States: $M = 0.79$, $SD = 0.60$), $t(19) = -1.11$, ns.

5.3.2.4. Social construals: Overall, Ngöbe narratives described more communication ($M = 0.86$, $SD = 0.57$) than U.S. narratives ($M = 0.39$, $SD = 0.32$), $t(19) = 2.28$, $p < .05$, $d = 1.04$. This trend held for both intentional communications (Ngöbe: $M = 0.34$, $SD = 0.43$; United States: $M = 0.11$, $SD = 0.23$), $t(19) = 1.54$, ns, and signaling (Ngöbe: $M = 0.52$, $SD = 0.38$; United States: $M = 0.29$, $SD = 0.28$), $t(19) = 1.60$, ns, but neither reached significance.

5.3.2.5. Affinity: Although the cultural difference was not reliable, Ngöbe tended to describe more social affinity between the coyote and badger ($M = 0.23$, $SD = 0.32$) than U.S. participants ($M = 0.06$, $SD = 0.18$), $t(19) = 1.51$, ns.

5.4. Discussion

The majority of U.S. participants interpreted the relationship as competitive, whereas the majority of Ngöbe participants saw it as cooperative. We also analyzed attributions of psychological and social capacities to animals. No cultural differences were found for references to mental states or decision making, suggesting at least some similarity in folkpsychological beliefs about basic intentional capacities of animals. However, Ngöbe referred more often to animal communication than U.S. participants, suggesting that concepts of animals' communicative capacities could be one factor shaping beliefs about cooperation. However, it is also possible that social construals simply depended upon the content of the narrative (cooperative or competitive). We follow up on this in Study 2.

6. Study 2

Study 2 was aimed at probing further into folktheories of ecological and social interaction among animals. We again asked Ngöbe and U.S. participants to interpret the coyote–badger

interaction, but added probes to assess the kinds of interactions respondents were willing to consider and believed most plausible. As a secondary focus, we investigated beliefs about social-cognitive capacities of animals.

6.1. Methods

6.1.1. Participants

Participants were 17 U.S. undergraduates (5 female) drawn from the same student population as in Study 1, and 16 Ngöbe adults (6 female) living in the primary research community and three nearby communities.[8] We selected more closely age-matched samples than those of Study 1. U.S. participants' ages ranged from 18 to 25 years (M = 19.76, SD = 2.20); Ngöbe participants' ages ranged from 18 to 35 years (M = 23.44, SD = 4.31). Recruitment, community permissions, informed consent, and compensations were the same as in Study 1.

6.1.2. Materials and procedure

Participants narrated the same coyote–badger story, presented via computer in English (United States) or book in Spanish (elicited from Ngöbe participants by the same interviewers as in Study 1). Interviews were audio-recorded and later transcribed.

Following their narrations, participants first were invited to offer alternative interpretations to the storyline they had presented. U.S. participants were asked: "Can you think of any other interpretations of the interaction between the coyote and the badger?" Pilot studies revealed that this question was vague for Ngöbe participants, so we asked how a child might interpret the story. This strategy communicated that we were looking for perspectives that differed from the participants' own without suggesting that they were wrong, and it elicited confident speculations.

Participants then answered three forced-choice questions concerning animals' capacities for communication, decision making, and morality (adapted from Gray et al., 2007). Each question followed the stem, "Do you think animals like the coyote and the badger:" (a) can communicate with one another (convey thoughts or feelings to one another)? (b) can form plans and make decisions? (c) are capable of telling right from wrong and trying to do the right (or wrong) thing? (for Spanish, see Appendix C). Note that the communication question referred to both intentional communication and signaling. We were interested in how participants would interpret communication, given the possibility of cultural differences in attributions of intentional communication to animals beyond "mere" signaling.

Finally, participants were asked which of three explanations of the coyote–badger relationship they believed was most accurate: (a) They are competing for the same kinds of small game; (b) They are randomly encountering each other as they hunt the same kinds of small game (neutral); (c) They are cooperating to hunt small game together (for Spanish, see Appendix D).

6.1.3. Narrative coding

Narrative interpretations of the coyote–badger interaction and alternative interpretations were judged according to the coding categories described in section 5.2.1. Explanations about communication were coded as described in section 5.2.2. Narrative interpretations, alternative interpretations, and communication explanations were independently coded by the first author and by a second coder blind to the hypotheses, with Kappas ranging from 0.79 to 0.95 ($ps < .01$) and percent agreement from 88% to 96%.

6.2. Results

6.2.1. Interpretations of interaction

Cultural differences were replicated in this new sample (see Table 3). The majority of U.S. participants (10/17) gave competitive interpretations, and only four gave cooperative accounts. In contrast, the majority of Ngöbe participants (10/16) gave cooperative interpretations, and only four gave competitive accounts. Of the remaining narratives, two (1 Unites States, 1 Ngöbe) were neutral and three (2 United States, 1 Ngöbe) were split narratives. The key 2 × 2 contrast between cooperation and competition (excluding split and neutral narratives) was reliably different across cultures, as analyzed by an $N-1$ chi-square analysis, $\chi^2(1, N = 28) = 4.96$, $p < .05$.

6.2.2. Alternative interpretations and judgments of best explanation

Regarding alternative interpretations, we were primarily interested in whether participants who initially saw competition were aware of the possibility of cooperation. (Aware-

Table 3
Measures of reasoning about the coyote–badger relationship, Study 2

Interpretations of the coyote–badger relationship in narratives				
Culture	Competition	Cooperation	Neutral	Split Narrative
United States (n = 17)	10 (59%)	4 (24%)	1 (6%)	2 (12%)
Ngöbe (n = 16)	4 (25%)	10 (63%)	1 (6%)	1 (6%)

Alternative interpretations of a competitive relationship (competitive narratives only)			
Culture	Cooperative Alternative	Could Not Offer Alternative	Another Competitive Interpretation
United States (n = 10)	4 (40%)	4 (40%)	2 (20%)
Ngöbe (n = 4)	3 (75%)	–	1 (25%)

Judgments of best explanation of the coyote–badger relationship			
Culture	Competition	Cooperation	Neutral
United States (n = 17)	7 (41%)	4 (24%)	6 (35%)
Ngöbe (n = 16)	3 (19%)	9 (56%)	4 (25%)

ness of competition is not in question; all participants noted that predators are killing prey, a form of negative interaction). As shown in Table 3, U.S. participants who originally saw competition were equally likely to say they could not think of an alternative interpretation (4/10) as they were to offer a cooperative one (4/10). Of the smaller sample of four Ngöbe participants who initially saw competition, three expressed awareness of cooperative alternatives. While these patterns conform to the predicted cultural trends, the small numbers fail to achieve statistical reliability.

Judgments of the best explanation for the coyote–badger relationship (competitive, cooperative, or neutral; see Table 3) revealed modal cultural preferences consistent with Study 1, with 7 of 17 United States, but only 3 of 16 Ngöbe participants selecting competition as the best explanation, and 9 of 16 Ngöbe but only 4 of 17 U.S. participants selecting cooperation. The cultural difference between competitive and cooperative (excluding neutral) judgments was marginally significant, $\chi^2(1, N = 23) = 3.49$, $p = .06$.

6.2.3. Beliefs about animal capacities

6.2.3.1. Decision making: The majority of both United States ($M = 0.88$, $SD = 0.33$) and Ngöbe participants ($M = 1.00$, $SD = 0$) agreed that coyote and badger were capable of decision making, $t(31) = 1.42$, ns, consistent with the coding results from narratives in Study 1.

6.2.3.2. Communication: The majority of both United States ($M = 0.94$, $SD = 0.25$) and Ngöbe participants ($M = 0.69$, $SD = 0.48$) agreed that animals like coyote and badger can communicate. The difference was marginally significant, $t(30) = -1.85$, $p = .07$, $d = -0.68$, but note that unlike Study 1, U.S. participants endorsed communication at a higher rate than Ngöbe participants.

The question concerning communication could be answered on the basis of intentional communication or signaling. Not all participants provided explanations for their judgment, but of those who did (9 United States; 7 Ngöbe), explanations were coded for attributions of intentional communication versus signaling. The majority of U.S. respondents (7/9) described forms of signaling (e.g., "*they may communicate their basic emotions but not thoughts*"), and none described intentional communication. In contrast, the majority of Ngöbe respondents (5/7) described intentional communication (e.g., "*They're intelligent and visit with each other*"), and none stated that communication was restricted to signaling. This cultural difference in attributions of intentional communication (0/9 United States; 5/7 Ngöbe), signaling (7/9 United States; 0/7 Ngöbe), and other explanations (2/9 United States; 2/7 Ngöbe) was reliable, $\chi^2(2, N = 16) = 11.94$, $p < .01$.

6.2.3.3. Morality: A pronounced cultural difference was found for judgments of animal morality, with Ngöbe participants ($M = 0.81$, $SD = 0.40$) much more likely than U.S. participants ($M = 0.41$, $SD = 0.51$) to agree that animals such as coyote and badger are capable of telling right from wrong and trying to act morally, $t(31) = 2.50$, $p < .05$, $d = 0.90$.

6.3. Discussion

Study 2 showed cultural differences in interpreting the coyote–badger interaction, replicating Study 1. Ngöbe participants tended to see individual coyote–badger cooperation, whereas U.S. participants favored competition. We also found both cultural similarities and differences in judgments of mental and social capacities of animals. The majority of participants in both cultures agreed that animals can engage in decision making and communication. In Study 1 we found that Ngöbe attend more to animal communications overall, and in Study 2 we observed that Ngöbe tended to attribute intentional communication, whereas U.S. participants focused on less complex signaling. The latter result held across both studies but was not statistically reliable in Study 1. We are currently following up these suggestive differences in beliefs about animal interspecies communication capacities.

Finally, Ngöbe were twice as likely as U.S. participants to agree that animals have a moral capacity to distinguish right from wrong. Overall, these results are consistent with the idea that Ngöbe attribute sophisticated social capacities to animals—indeed, many respondents spoke of conversations, customs, and even religiosity among animals.

7. Conclusion

Western ecological theory has tended to see one kind of interaction—competition—as the driving force of ecosystems. The current studies assessed the role of competitive principles in folkecological cognition across two cultures. The results paint a consistent picture, indicating that a competitive orientation at the level of individuals is a feature of particular cultural models. The majority of U.S. college students interpreted and explained an interspecies hunting relationship in terms of competition, whereas most Ngöbe understood it in terms of cooperation. If expert knowledge in the ecological domain leads to a competitive frame, then Ngöbe individuals, as experts in ecological relationships more generally, should have preferred competition as a first principle for explaining interspecies interaction. That they did not suggests that this preference is tied to cultural models.

7.1. Further considerations for folkecology

The present findings align with previous work with another Indigenous group, the Itza' Maya, showing their folkecological models emphasize a greater range of positive interactions than non-Indigenous models (Atran & Medin, 2008), but here we go further in examining competition versus cooperation at the level of individual interactions rather than at the level of individual kinds. Of course, several complexities remain. First, it is not clear whether Ngöbe are better able to detect the difference between cooperation and competition, or if they are looking at nature through a cooperative lens, even as U.S. participants are using a competitive lens. In principle one could distinguish between these two possibilities by sampling a range of cooperative and competitive scenarios and analyzing discrimination

accuracy versus a bias to see one kind of relation as present. However, this assumes that there is only one "correct" answer, and it may risk oversimplifying complex ecological dynamics (Shouse, 2003). It also assumes that participants are focused on the same level and scale of analysis when reasoning about any given relationship. However, cultural models may facilitate attention to different size networks and causal chains, a difference that may itself be intrinsic to folkecological conceptual models (Medin et al., 2013).

Even if we assume these findings reflect interpretive frames rather than accuracy per se, the extent to which such interpretive principles would generalize across types of interactions is unclear. The current findings may be tied to one or more features particular to the coyote–badger interaction (e.g., folk beliefs about predators, coordinated cooperation, or animal psychological capacities). Although U.S. participants preferred competitive accounts in this case, surely they recognize many other cooperative relationships (e.g., between pollinators and flowers). To address generalizability, folkecological reasoning should be examined across a broad range of agents, levels, and scales of analysis.

7.2. Cultural folkpsychologies

One implication of our findings is that folkpsychological theories can support different readings of (some) interspecies relationships. Our results suggest that Ngöbe folktheories accommodate a wider range of social roles for animals, including capacities for communication and morality that may pertain to beliefs about coordinated cooperation. These findings align with anthropological research on Indigenous views of animal social and cognitive capacities (e.g., Harvey, 2005).

Another consideration concerns the possibility of distinct interpretive frameworks for predator–prey roles. Some Indigenous informants recognize that prey "give themselves" to predators. Our Ngöbe coauthors point out that taking life is affectively loaded for human and nonhuman predators alike, and suggest that some animals may "feel bad" when killing prey—an observation that resonates with ethological research on the ritualized killing behavior of some predators (Pierotti, 2011, pp. 53–57). On this view ecologies are structured by intentional social interactions, rather than depersonalized positive or negative interactions. This folkpsychological component of ecological reasoning is an issue for further research (ojalehto, Waxman, & Medin, 2013).

7.3. Interdisciplinary intersections and broader considerations

Incorporating predictions drawn from ethnographic surveys of Western and Indigenous societies allowed us to ask a new question about folkecological cognition using a storytelling method. The resulting insight—that cultural models may differentially privilege cooperative or competitive principles—may help to explain previously observed cultural differences in folkecological models. Our results also extend anthropological reports that Indigenous Amerindian ecological models emphasize cooperation, by demonstrating systematic application of these principles to a novel case of interspecies interaction. At the same time, these findings document a possible competitive lens in Western cultural

models of biological interactions. Integrating anthropological and psychological insights such as these can foster research approaches that avoid some potential pitfalls of either discipline acting in isolation (Astuti & Bloch, 2012).

By considering how concepts of social interaction among animals may be relevant to environmental cognition, the current studies challenge the idea that folkpsychology concerns (only) humans and that folkecology excludes intentional agency. As the coyote–badger relationship illustrates, nonhuman agents can be viewed as intentional social actors (Bekoff, 2004), and understanding how people conceptualize the latter will be crucial to a fuller understanding of folkecological cognition.

Our research is also related to the broader question of how people see themselves in relation to the rest of nature. Recently, researchers have suggested that U.S. undergraduates may take a zero-sum approach to conservation by viewing the needs of humans and animals as in competition (Markowitz et al., 2013). In contrast, the Ngöbe cultural model may foster a view of ecologies as social communities where cooperation between species (including humans) is not only possible but plausible. More research is needed to explore these possibilities, but the practical consequences of such a framework are potentially far-reaching. Concepts of ecological interaction may shape environmental cognition and action in ways that ultimately (re)shape ecologies themselves.

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Notes

1. In addition, a Google Ngram search for the terms “species cooperation” versus “species competition” in English-language corpora shows that “species competition” is an order of magnitude more frequent.

2. Ecologists characterize the coyote–badger relationship as a nonevolved or nonobligate mutualism in the form of a "short-term, two-species social system" (Minta et al., 1992, p. 819). Both "cooperation" and "mutualism" refer to interactions where both parties benefit; we refer to cooperation following recent usage (e.g., Dugatkin, 2002, p. 533).
3. The social-psychological mechanisms involved in animal cooperation are debated among ecologists (Bekoff, 2004; Clutton-Brock, 2009; Dugatkin, 2002) and psychologists (Stevens & Hauser, 2004). Just as scientists believe that psychological capacities are critical to explaining animal cooperation (or lack thereof), so may laypersons.
4. In interviews with Ngöbe participants, we introduced the animals with their species names (el coyote, la tejón), but often referred to coyote and badger, respectively, as "wolf" (el lobo) or "fox" (la zorra), as these terms were more familiar to Ngöbe participants.
5. Our coding scheme distinguished signaling from intentional communication in accordance with ethological definitions, where signaling may be used to change a listener's behavior but lacks communicative intent: "they do not call with the specific goal of informing others" (Seyfarth & Cheney, 2003, p. 168).
6. For tables larger than 2×2, an exact test should be used if more than 20% of expected cell counts are less than 5 but all counts are equal to or greater than 1 (Yates, Moore & McCabe, 1999).
7. For 2×2 tables, the $N-1$ chi-square is recommended for small samples (Campbell, 2007); the linear-by-linear association test generated in SPSS CROSSTABS is equivalent to the $N-1$ chi-square (Weaver, 2013).
8. We presented Study 1 results to the primary research community in March 2013, so some residents were aware of the coyote–badger story. We visited other communities to interview naive participants in addition to the small set from the primary community.

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Appendix A: Task instructions to participants in English and Spanish (Studies 1 and 2)

English: I have a picture book for you to talk about. I will ask you to look at the different scenes and tell me what is happening in the story. Please look through

the entire storybook for as long as you want, but try to look through the whole book at least once. Please pay attention to what the characters in the story are doing, and try to understand what things are happening in the story. When you're ready to tell me what's happening in the story, please start with the first page and go through the story page by page, telling me what is happening at each page in the story.

Spanish: Tengo un libro ilustrado para que usted hable acerca de él. Le voy a preguntar que mire a las diferentes escenas y me diga lo que está pasando en el cuento. Por favor tome todo el tiempo que quiera para mirar todo el libro, pero trate de ver todo el libro por lo menos una vez. Por favor ponga atención a lo que los personajes están haciendo y trate de entender lo que está pasando en el cuento. Cuando usted esté listo para decirme lo que está sucediendo en el cuento, por favor empiece con la primer página y continúe con el cuento página por página diciéndome lo que esta pasando en cada página del cuento.

Appendix B: Original Spanish excerpts from narratives, with English glosses, from Table 1 (Study 1)

Se hicieron como un acuerdo para ver cómo podían atrapar. . .

"*A union. . .they made like an agreement to see how they could trap*."

Y ahora que se encuentra buen amigo ahora.

"*And now they find themselves good friends*."

Appendix C: Spanish questions regarding animal social-cognitive capacities (Study 2)

Crees usted que las animales como el lobo/coyote y la zorra (*Do you think animals like the coyote and the badger*):

Communication: . . .¿se pueden (o tienen capaz de) comunicar uno con el otro y expresar pensamientos o sentimientos el uno al otro? (*can communicate with one another [convey thoughts or feelings to one another]?*)

Decision making: . . .¿se pueden (o tienen capaz de) crear planes y tomar decisiones? (*can form plans and make decisions?*)

Morality: . . .¿se pueden (o tienen capaz de) distinguir entre lo bueno y lo malo y de intentar de hacer lo correcto (or lo malo)? (*are capable of telling right from wrong and trying to do the right* (*or wrong*) *thing?*)

Appendix D: Spanish questions regarding best explanation of the coyote–badger relationship (Study 2)

Cuál es la mejor explicación de la relación entre el lobo/coyote y la zorra? (*Which is the best explanation of the relationship between coyote and badger*)?

1. Ellos dos están competiendo (o están en un concurso) para los mismos tipos de presa (*They are competing for the same kinds of small game*);
2. Ellos se toparon con uno al otro por casualidad mientras que le están cazando los mismos tipos de presa (*They are randomly encountering each other as they hunt the same kinds of small game*);
3. Ellos dos están cooperando para cazar la presa juntos (o están trabajando juntos en la caza) (*They are cooperating to hunt small game together*).