2017 - *Cognitive Psychology*, *95*, 50-78. https://doi.org/10.1016/j.cogpsych.2017.04.001

Grounding principles for inferring agency: Two cultural perspectives

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Abstract

The present research investigates cultural variation in grounding principles for inferring agency. Our motivating question is whether cultural diversity in agency concepts reflects an animistic overextension of a single (universal) folkpsychology, as argued by many researchers, or an alternative folktheory of communication based on relational principles. In two experiments, a mind-perception measure was adapted for interviews with indigenous Ngöbe adults in Panama and US college students, with a focus on beliefs concerning non-animal kinds (plants, abiotic kinds, complex artifacts). Agency attributions varied systematically, with Ngöbe ascribing greater agency to non-animal natural kinds and US participants ascribing greater agency to complex artifacts. To assess principles for inferring agency, we used several converging measures. (1) Coding analysis of explanations revealed divergent interpretations of agency as a prototypically human capacity requiring consciousness (US), or as a relational capacity expressed in directed interactions (Ngöbe). (2) Experimentally introducing a relational framing of agency probes facilitated Ngöbe but not US agency attributions. (3) Three key dimensions of agency concepts (experience, cognition, animacy) are organized differently across cultures. (4) A Bayesian inferential approach to cultural consensus modeling confirmed the presence of two distinct consensus models and revealed several forms of within- and cross-group variability. Together, these findings indicate that conceptual frameworks for agency differ across Ngöbe and Western communities. We conclude that Ngöbe concepts of ecocentric agency derive from a distinct theory of folkcommunication rather than overextensions of Western folkpsychology, with significant implications for domain-specificity theory and our understanding of cognitive diversity.

Keywords: agency; folkpsychology; mind perception; culture; domain specificity; animism

1. Introduction

Agents captivate our attention and animate our worlds. A major goal for cognitive science is to understand how people recognize an agent and conceptualize its capacity to act. These concepts are integral to language, causal reasoning, folk theories, and mind perception, and actively structure social cognition and moral reasoning (e.g., Banaji & Gelman, 2013; Carey, 2009; Lowder & Gordon, 2015; Waytz et al., 2010). In fact, agency concepts are so fundamental that they are often presumed universal (Johnson, 2003; Spelke & Kinzler, 2007; Sperber & Hirschfeld, 2004). At the same time, it is increasingly clear that agency concepts are multifaceted. Exploring the underlying principles for inferring agency is the focus of a growing body of research, typically among Western populations (Gray et al., 2007; Knobe, 2011; Tamir et al., 2016). While some aspects of agency perception may be universal, we believe there is striking cultural variation in concepts of agency based on grounding principles for inferring agency. Here we report one such case, contrasting conceptual frameworks for agency among indigenous Ngöbe of Panama and US college students.

2. Background

Agency, broadly defined as the capacity to act, is a signature property of moving, living, and sentient kinds. Depending on the interpretive stance adopted, an act of agency may be conceptualized quite differently depending on whether it is thought to arise from purely physical mechanisms or meaning-laden social processes, for instance.

How people parse these conceptual categories for agency is an important question for cognitive science (Csibra & Gergely, 2007; Lewis, 1990). One influential view holds that agency is conceptualized under separate frameworks corresponding to specific ontological kinds (Wellman & Gelman, 1992). On this domain-specificity account, which has been developed primarily among Western cultures, people intuitively understand action in terms of distinct folktheories for force dynamics of physical kinds (folkphysics), teleological agency of living kinds (folkbiology), or mental agency of animate kinds (folkpsychology). For instance, individuals may interpret movement toward the sun differently for a cloud versus a plant (physical versus biological), and both differently from a person's movement toward the sun (psychological) (Gutheil et al., 1998; Opfer & Gelman, 2001; Opfer & Siegler, 2004).

Within the folkpsychological domain itself, a further distinction has been proposed between two forms of mental agency associated with either experiential or cognitive capacities (Gray et al., 2007). These two dimensions of mind perception are thought to involve distinct inferences about biological versus representational faculties, respectively (Knobe, 2011). For example, human-created entities such as artificial intelligence or corporations are judged high on cognition but low on experience (as they are not alive), whereas nonhuman animals are judged high on experience but low on cognition (as they do not have conscious representations). This seems to reflect a mirroring of the broader folkbiology-folkpsychology distinction within the domain of psychology proper.

Domain-specificity is widely seen as a universal feature of cognition (Gelman & Legare, 2011; Sperber & Hirschfeld, 2004). At the same time, it is well known that cultures diverge in explicit beliefs about agency. For instance, many indigenous cultures take a broad view of agency by holding that non-animal natural kinds like plants, minerals, celestial bodies and abiotic forces (e.g., thunder, ocean) may perceive, respond, and communicate (Hallowell, 1960; Harvey, 2005). These are capacities that most Westerners, researchers included, view as psychological ones. As such, proponents of domain-specificity theory have treated these cultural beliefs as overextensions of a universal concept of mind beyond its proper domain (Atran & Norenzayan, 2004; Boyer, 1996). These overextension accounts argue that indigenous understandings of nonhuman agency represent counterintuitive, supernatural, or animistic concepts (Barrett, 2000; Boyer, 2003; see also Guthrie et al., 1980) (but see Bird-David, 1999; Ingold, 2006; Kohn, 2007).

An alternative possibility is that presumed overextensions of folkpsychology actually reflect different cultural concepts of agency stemming from diverse principles for inferring agency, and/or different notions of what belongs in the agency domain. As noted above, current theories of folkpsychology in the West emphasize human minds and artifacts, and consequently these theories tend to focus on understanding anthropocentric forms of agency. As an alternative to this, one framework that has been extensively discussed in the literature on indigenous epistemologies is a folktheory where agency is primarily understood as a naturalistic capacity for relational interaction with other agents and environments (Bird-David, 1999; Danziger & Rumsey, 2013; Harvey, 2005; Kohn, 2013). Working from multiple disciplines and Native perspectives, scholars have argued that indigenous theories afford greater recognition of nonhuman agency as it is expressed in diverse ways across the natural world (Kimmerer, 2013; Pierotti, 2011), and that these theories do not share the overtly mentalistic emphasis of Western folkpsychology (e.g., Ingold, 2011; ojalehto & Medin, 2015; Walker, 2013). This raises the possibility that concepts of agency may be organized differently across cultures.

Our research focuses on the indigenous Ngöbe of Bocas del Toro, Panama. The primary research community is located on a forested island in the Caribbean that forms a political annex to the indigenous autonomous region Comarca Ngöbe-Bugle. The community hosts about 600 people in several dispersed family hamlets that lie within an hour's walking or canoeing distance of each other. Community members' lifestyles are closely coordinated with the surrounding ecology through agroforestry, fishing and diving, and other subsistence practices (Gordon, 1982). Our own experience (S.G.G.) and prior research (ojalehto et al., 2015; ojalehto et al., 2013) indicate that Ngöbe attend to nonhuman agency and ecological relationships in ways that resonate with indigenous relational epistemologies more generally.

Building on these observations, we propose that cultural variability in conceptual frameworks for agency can be distinguished along (at least) two dimensions: (a) ecocentric or anthropocentric prototypes for agency, following from a focus on natural actors broadly or humans specifically; and (b) distinct causal theories of agency as a relational capacity (reasoning about interactions) or a psychological capacity (reasoning about representational mental states). On this account, people may attend to similar basic cues for agency perception across cultures (e.g., Barrett et al., 2005), but those cues acquire very different meanings across cultural frameworks. Our current studies, then, do not ask whether people detect agency differently but whether they infer capacities differently given that agency has been detected.

As we will see, Ngöbe informants focus on different dimensions of agency across a different scope of actors than would be predicted by current (Western) accounts of folkpsychology. From this we argue that grounding principles for inferring agency vary across cultures, leading to folktheories that track distinctive domains of agency: Ngöbe take a communicative stance on agency as a relational capacity to dynamically interact with the world, whereas US individuals take a psychological stance on agency as an individual capacity to internally represent the world.

3. Current research

In two experiments, we adapted the mind perception survey (Gray, et al., 2007) to assess concepts of agency among US college students and indigenous Ngöbe adults of Panama. The key differences in the two hypothesized cultural frameworks center on concepts of agency for non-animal kinds: specifically, plants, abiotic kinds (i.e., nonliving natural kinds),[1] and complex computerized artifacts (henceforth

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[1] Entities such as the sun, ocean, or rocks are often referred to as nonliving natural kinds in the Western literature, but we refer instead to *abiotic kinds* (defined by Merriam Webster as "not biological; *especially*: not involving or produced by organisms") because many Ngöbe individuals consider these kinds to be alive, as we will report. For clarity, we will still refer separately to abiotic kinds versus biological organisms (humans, animals, plants), following Western nomenclature.

referred to simply as complex artifacts). We predicted that Ngöbe participants would attribute greater agency to plants and abiotic kinds relative to complex artifacts (and as compared to US participants), on the basis of those entities' capacity to interact with the environment. On an anthropocentric prototype, we predicted the opposite: namely, that US participants would recognize greater agency for complex artifacts relative to plants and abiotic kinds (and as compared to Ngöbe), due to their human-designed information processing capacities.

The goal of Experiment 1 was twofold. First, we sought to establish whether there are cultural differences in attribution of agency capacities to various natural and artifact non-animal kinds.[2] Our second goal was to assess conceptual frameworks by analyzing participants' explanations for their agency attributions. We predicted that Ngöbe and US respondents would draw on different framings of and criteria for the capacities under question, corresponding to distinct folktheories of agency.

Experiment 2 aimed to replicate the findings from Experiment 1 with larger samples and provide additional insight into these differences with several measures. First, an experimental manipulation used relational framings of agency probes in order to assess the inferential principles underlying proposed cultural frameworks of agency. Second, additional probes were included to explore the cultural organization of conceptual dimensions relevant to agency concepts, including cognition, experience, and animacy. Last, we used cultural consensus modeling to detect latent conceptual models and identify the conceptual features and individual-level differences associated with each model.

4. Experiment 1

4.1. Participants

Participants in Experiment 1 were indigenous Ngöbe adults of Panama (n = 11; 3 female) and US college students (n = 11; 4 female). Ngöbe participants' ages ranged from 22-63 years (M = 34.73, SD = 12.42). Experience with formal schooling ranged from 0-12 years (M = 6.82; SD = 3.09). Ngöbe participants were bilingual in Spanish and their native Ngöbere. Participants were recruited through household visits or community meetings. Community permission and individual informed consent were received. Ngöbe participants received a small compensation and a donation was made to the community fund.

US participants were undergraduate students enrolled in an introductory psychology course at Northwestern University in the Greater Chicago Area. Ages ranged from 18-21 years (M = 19.45, SD = 1.21). All participants were fluent English speakers. The students came from predominantly upper-middle class backgrounds (60%); and identified as Caucasian (57%), Asian/Asian-American (22%), Black/African-American (7%), Latino/Latina (3%) or other (12%). US participants completed informed consent and received partial course credit for participating.

4.2. Methods

As part of a larger interview (identical for both groups), participants completed an adapted version of the mind-perception survey (Grey et al., 2007) (see Appendix A1). Participants rank-ordered 16 entities in terms of their capacity for several kinds of agency, allowing for ties (indicating equal capacity) and exclusions (indicating no capacity). Five representative capacities were selected from the original 18-item mind perception survey: thought, communication, morality, hunger and desire.[3] Each participant ranked (on average) only three of the five capacities to keep interviews of reasonable duration.

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[2] These capacities (e.g., thought, communication) are typically characterized as mind-perception capacities in the psychological literature, but we refer instead to agency capacities because the specific nature of these conceptual commitments is in question.

[3] The five probes were selected to include capacities associated with both mind-perception dimensions, but specifically probing these two dimensions was not the goal of Experiment 1; see Experiment 2.

Participants were probed to explain a subset of their rankings. Ngöbe and US respondents provided a similar number and length of explanations for each capacity and kind (for details, see Appendix A4).

Stimuli were cards with color photographs of individual entities, and included 4 humans (old woman, young woman, infant, fetus), 3 animals (chimp, dog, cow), 2 plants (banana, manioc [Panama]; lettuce, strawberry [US]), 5 abiotic kinds (sun, clouds, rain, ocean, rocks), and 2 complex artifacts (robot, computer). Notably, previous mind-perception surveys have rarely included plants or abiotic kinds, preferring instead computerized artifacts; this is itself a commentary on Western views of agency.

Participants were interviewed in Spanish (Panama) or English (US). The Spanish protocols were independently forward- and back-translated by two trained research assistants in the US. Before use in Panama, Spanish protocols checked for local validity by a trilingual (in Spanish, English, and Ngöbere) researcher (S.G.G.). All interviews were audio-recorded and transcribed, and Spanish responses were translated into English for coding analysis.

4.3. Agency attributions

4.3.1. Data analysis

We used a weighted rank system (weighted by level in order to account for ties) to calculate mean ranks, with ranks assigned by level and lower numbers indicating higher rank (range: 1-16). Ties were treated as the median score across that level (e.g., if two items were tied for the first level, each received a score of 1.5), and excluded items were scored as tied for last place (e.g., if two items were excluded, each received a score of 15.5).

Agency attribution profiles. Cultural models can be inferred by comparing how non-animal kinds are ordered relative to one another within each cultural group.[4] Focusing on the critical comparison set of three non-animal kinds (plants, abiotic kinds, and complex artifacts), profiles could fall under one of two general models. On a hypothesized ecocentric prototype, Ngöbe responses should follow a natural kinds model (NKM) where both plants and abiotic kinds are included more frequently and ranked above complex artifacts. On a hypothesized anthropocentric prototype, US responses should follow an artifact kinds model (AKM) where complex artifacts are included more frequently and ranked above natural kinds, either abiotic kinds or plants or both.

We did not predict marked cultural differences for animals and humans, or for mammals versus non-mammals, on these particular measures. Ngöbe and US individuals may in fact take distinct views of animal agency, particularly for complex capacities such as morality as we have found in other studies (ojalehto et al., 2015). But the present measures were aimed at discriminating coarse-grained differences across the animal/non-animal divide rather than subtle distinctions in the actual degree of capacity accorded to any one kind.[5]

4.3.2. Results

Our main predictions concerning culturally distinct frameworks for nonhuman agency were borne out, as summarized in Table 1. Here we focus on results key to the hypothesized cultural differences. (Main effects for kind are summarized in Table 1; for other detailed results see Appendix A2.) We analyzed results by considering which entities were included in agency rankings (inclusion) and by

[4] Because exclusions were scored as tied for last place, mean rank is insensitive to differences between items that were excluded and those included but ranked last. For this reason it is most straightforward to assess cultural differences in terms of differences in inclusion profiles, as we do in the first three sections of Experiment 2 results.

[5] On an anthropocentric prototype, one might also predict that US participants would rank humans relatively higher, and mammals relatively higher than non-mammals, than Ngöbe participants. Assessing these possibilities would require an interval measure of perceived distance between human, mammal, and non-mammal capacities, such as a rating scale. The present measures of ordinal ranks and inclusion rates are not sensitive to such differences.

Table 1. Mean rankings and percent inclusions for agency[a]

	Mean Percent Inclusions							Mean Ranks						
	Ngöbe (n = 11)		US (n = 11)			Overall (N = 22)		Ngöbe (n = 11)		US (n = 11)			Overall (N = 22)	
Kind	*M*	*SD*	*M*	*SD*	*t*-test	*M*	*SD*	*M*	*SD*	*M*	*SD*	*U*-test	*M*	*SD*
Humans	0.93_a	(0.10)	0.85_a	(0.14)	*ns*	0.89_a	(0.12)	3.86_a	(1.58)	4.21_a	(.58)	*ns*	4.03_a	(1.18)
Animals	1.00_a	(0.00)	0.83_a	(0.21)	2.79*	0.91_a	(0.17)	6.51_b	(1.94)	5.66_b	(1.16)	*ns*	6.08_b	(1.62)
Plants	0.55_b	(0.33)	0.21_b	(0.26)	2.72**	0.38_b	(0.34)	10.65_c	(1.23)	$11.08_{c,d}$	(1.19)	*ns*	10.87_c	(1.20)
Abiotic kinds	0.45_b	(0.37)	0.08_b	(0.17)	3.04**	0.26_b	(0.34)	11.00_c	(1.71)	11.78_d	(0.85)	*ns*	11.39_c	(1.38)
Complex artifacts	0.38_b	(0.36)	0.29_b	(0.26)	*ns*	0.34_b	(0.31)	12.35_c	(1.55)	10.58_c	(1.40)	25.0*	11.47_c	(1.70)

[a] Agency is a composite measure of thought, communication, morality, hunger, and desire.

[b] Mean ranks: Lower numbers indicate higher ranks (range: 1 - 16); with excluded items scored as tied for last place.

[c] Main effect for kind: Means in the same column not sharing the same subscript differ significantly at $p < .05$ in Wilcoxon signed-rank tests.

Note: * Indicates $p < .05$; ** $p < .01$; *** $p < .001$.

their mean rank (ranking). Each measure was averaged by kind across the five agency capacities, then analyzed with a 2 (culture) X 5 (kind: artifact, abiotic kind, plant, animal, human) repeated-measures ANOVA. Degrees of freedom were corrected using Huynh-Feldt estimates due to violation of assumption of sphericity (inclusion: $\chi^2(9) = 28.31$, $p < .01$, $\varepsilon > .75$; ranking: $\chi^2(9) = 18.02$, $p < .05$, $\varepsilon > .75$).

Inclusions. Agency inclusions for each kind differed substantially across cultures, $F(3.24, 64.87) = 2.86$, $p < .05$, $\eta 2 = .13$. As predicted on an ecocentric prototype, Ngöbe were more likely than US participants to include non-animal natural kinds in their agency ranks, including both plants (Ngöbe: $M = 0.55$, $SD = 0.33$; US: $M = 0.21$, $SD = 0.26$), and abiotic kinds (Ngöbe: $M = 0.45$, $SD = 0.37$; US: $M = 0.08$, $SD = 0.17$), as well as animals (Ngöbe: $M = 1.00$, $SD = 0$; US: $M = 0.83$, $SD = 0.21$), $ps < .05$. However, the two groups did not differ reliably on inclusion of complex artifacts. Thus, our prediction that US participants would be more likely to include complex artifacts on an anthropocentric prototype was not borne out.

Rankings. We considered agency attribution profiles by analyzing differences in mean ranks for each non-animal kind across cultures, as well differences in the mean rank ordering of those kinds within each cultural group. Mean ranks varied by kind across the two groups, $F(3.47, 69.35) = 2.70$, $p < .05$, $\eta 2 = .12$. Follow-up comparisons using the Mann-Whitney U test confirmed that US rankings were significantly higher than Ngöbe rankings for complex artifacts (US: $M = 10.58$, $SD = 1.40$; Ngöbe: $M = 12.35$, $SD = 1.55$), $U = 25$, $p < .05$. Ngöbe tended to rank plants and abiotic kinds higher than US participants, but these differences did not reach reliability.

Within-culture pair-wise rank comparisons using the Wilcoxon signed-rank test revealed modest differences between non-animal kinds consistent with the hypothesized agency frameworks, although not all the predicted differences reached reliability. Ngöbe followed the predicted natural kinds model by tending to rank plants and abiotic kinds above complex artifacts, and the higher rank for plants relative to complex artifacts was marginally significant ($Z = -1.89$, $p = .06$). The opposite held for the US rank profile, which followed an artifact kinds model where complex artifacts were ranked significantly higher than abiotic kinds ($Z = -2.03$, $p < .05$).

4.4. Interim summary

So far, US attribution profiles are consistent with a view of psychological agency as a property primarily restricted to humans and animals, whereas Ngöbe profiles align with a more ecologically oriented view of agency as a capacity expressed by many natural kinds including plants and abiotic kinds. The inferential principles at stake in these cultural frameworks for agency were further investigated by analyzing participants' explanations for their agency rankings.

4.5. Explanatory frameworks for agency

An entity can express agency in many ways. Whether those expressions are interpreted as relevant to a particular capacity hinges on one's conception of agency. We assessed cultural stances on this matter by analyzing participants' explanations for their agency rankings.

Building on previous accounts of Western and indigenous cultural epistemologies (see Medin et al., 2013), as well as the (predominantly Western) literature on folkpsychology and mind-perception, we developed a coding scheme to assess constructs associated with each hypothesized cultural framework.

Our first hypothesis holds that conceptual frameworks for agency are structured around different prototypes, which we expect will correspond to distinct framings of agency. If US folkpsychology treats humans as the prototype, this should be linked to a *scalae naturae* model where organisms are hierarchically ordered on a scale from simple to complex human agency. In contrast, Ngöbe are predicted to frame agency as a pluralistic capacity for relating (with others and the environment) that is exercised by many human and nonhuman entities. Accordingly, we predicted that US explanations would contain more human-centric and scalar framings of agency, while Ngöbe explanations would contain more relational framings of agency.

Our second hypothesis holds that cultural frameworks take different stances on the relevant causal principles for inferring agency—namely, as an interactive or a psychological phenomenon. Accordingly, Ngöbe and US explanations are expected to focus on different indicators of and criteria for ascribing agency.

4.5.1. Coding scheme

All explanations were analyzed with a coding scheme designed to assess framings of, and explanatory constructs considered relevant to, agency on both hypothesized cultural frameworks (see Tables 2 and 3). Our coding system measured the extent to which participants' explanations focused on the following variables: human-centric, scalar, or relational framings of agency; internalized or interactive indicators of agency; and consciousness or directedness as criteria for agency (each is detailed below). Reference to a construct of interest (e.g., brain) was coded whether it was invoked for agency endorsement (e.g., "chimps can think because they have a brain") or denial (e.g., "plants cannot think because they don't have a brain"). Coding categories were not mutually exclusive.

Table 2: Coding categories related to anthropocentric psychological agency

Code	Description	Examples
Human-centric framing	Implicates humans as prototypical agents by referring to: (i) Human-nonhuman comparisons (ii) Human perception of agency (iii) Human intervention on agency	(i) Animals "don't have the capacity to think like people" (NG, Th.) (ii) Animals "not so much, because they're difficult to interpret" (US, Com.) (iii) Dogs have "been conditioned to act that way" (US, Mor.)
Scalar framing	Frames agency as scalar capacity by: (i) Assessing agency in terms of hierarchical scales or timelines (ii) Hedging the sense in which an entity has capacity, implying an ideal	(i) Mammals "tend to be smarter, have a more complex brain" (US, Th.); Baby will "given time, overcome the chimpanzee" (US, Mor.) (ii) Plants "feel emotion in *like a different sense*" (US, Com.); "But the plant doesn't *really* get hungry" (NG, Hun.)
Internalized indicators	Focus on internal parts or substrates underlying indicators of agency: (i) mind or brain (ii) interior or bodily substrates	(i) Animals "have receptors and stuff in their brain that signal when they're hungry" (US, Hun.) (ii) Robot has "electric cables in their body" (NG, Com.); Human "body requires nutrients" (US, Hun.)
Consciousness	Consciousness is criterial to agency, as indicated by: (i) self-awareness (ii) autonomy over own actions (iii) (not) instincts or mere reactions	(i) Plants "perform actions" but "have no concept of being moral" (US, Mor.); Baby "can't recognize" its hope (US, Des.) (ii) Animal's "brain doesn't control what he's communicating" (US, Com.) (iii) Cows have "primal instinct rather than...more technical cognition levels" (US, Th.)

Abbreviations: (NG/US) Ngöbe/US; (Hun.) Hunger; (Th.) Thought; (Mor.) Morality; (Des.) Desire; (Com.) Communication

Table 3: Coding categories related to ecocentric relational agency

Code	Description	Examples
Relational framing	Frames agency as relational capacity by referring to interactions and other-orientated states involving: (i) other agents (ii) environments	(i) Chimps "have a good sense of social structure" (US, Th.); Cows "know their owner" but are "fierce" to others (NG, Mor.) (ii) "Plants have hunger, for the rain that falls" (NG, Hun.); Sun "communicates with [water] in the moment of rising" (NG, Com.)
Interactive indicators	Focus on observable interactions as cues to agency, including: (i) Behavioral patterns (ii) Means of expressing agency	(i) Dogs have "certain things that they do or don't do, when they live with people" (US, Mor.) (ii) Plants "communicate in the way they go growing" (NG, Com.); Animals "have their distinct forms to wait, express, know" (NG, Des.)
Directedness	Directedness is criterial to agency, as indicated by: (i) goal-directed needs or wants (ii) teleological processes (iii) variable states of the entity	(i) Plants are "hungry for something that will allow them to survive" (US, Hun.) (ii) Sun "has the thought to light the world" (NG, Th.); Rain "has thoughts, that it falls as the rain" (NG, Th.) (iii) Oceans "have a moment where they wait for the change" (NG, Des.)

Abbreviations: (NG/US) Ngöbe/US; (Hun.) Hunger; (Th.) Thought; (Mor.) Morality; (Des.) Desire; (Com.) Communication

The dependent variable was the percent of explanatory content associated with a given coding category (number of codes divided by total words in explanation, times 100).

Two raters (b.o. and a US research assistant blind to the hypotheses) each coded half the data independently, after working together to iteratively develop and train on the coding scheme. Inter-rater agreement was good, with intra-class correlations for each coding variable ranging from r = .62 to r = .85, all ps < .01, (df = 232) (see Appendix A3, Table A1). To ensure the most accurate code assignment possible, both raters separately coded nearly all the data (90% of explanations, including those used to establish reliability), disagreements were discussed, and the consensus decision was used for the final data set.

4.5.2. Results

The results roundly supported the proposal for two distinct conceptual frameworks, as confirmed by significant cultural differences observed across the majority of coding categories (summarized in Table 4). All tests reported below are 2 (culture) x 2 (kind: animate versus inanimate, as defined on Western categories) repeated-measures ANOVAs on the coding variable of interest. Data were collapsed over the five kinds into two categories (in/animate) to reduce empty cells, given that not all participants provided specific explanations for each kind on every ranking (this split allowed us to include 10 of 11 participants from each cultural group). Here we report only results that reached statistical significance (see Appendix A4 for detailed results).[6]

(i) Human-centric framing of agency

On an anthropocentric model, we predicted that US explanations would treat humans as the exemplar or standard agent, and thus contain more human-centric framings of agency. An anthropocentric framing was assessed by coding for (i) comparison of nonhumans to humans (e.g., chimps think because "they're very similar to human minds"); (ii) taking a human vantage point on perceiving or appraising nonhuman agency (e.g., animals have minimal communication because "they're difficult to interpret"); or (iii) human intervention on nonhuman agency (e.g., dogs only behave morally because they are trained to follow rules).

As predicted, there was a main effect for culture, $F(1,18) = 8.65$, $p < .01$, $\eta 2 = .33$, such that US participants provided substantially more human-centric content (M = 2.66%, SD = 1.93%) than Ngöbe participants (M = 0.78% SD = 0.63%).

[6] There were no main effects for kind (in/animate) or interactions of culture by kind for any coding outcome variable.

(ii) Scalar framing of agency

Following from an anthropocentric prototype, we also predicted that US explanations would treat humans as the most complex or "developed" agents, and thus contain more scalar framings of agency. A scalar framing was defined as explanations that (i) assess agents according to hierarchical taxonomies or developmental scales (e.g., mammals "tend to be smarter, have a more complex brain"); or (ii) hedge the sense in which an entity possesses a capacity (e.g., in an "abstract" or "different" sense), implying an anchoring concept based on a prototypical (human) agent.

The predicted main effect for culture emerged, $F(1,18) = 7.82$, $p < .05$, $\eta 2 = .30$, such that US explanations relied much more on scalar framings (M = 6.22%, SD = 2.54%) than Ngöbe explanations (M = 2.71%, SD = 3.06%).

(iii) Relational framing of agency

On an ecocentric model, we predicted that Ngöbe explanations would frame agency in terms of relational action, both social and ecological. A relational framing was assessed by coding references to relationships, interactions, and other-oriented states involving (i) other agents (e.g., "babies know who their mother is") (social relations); and (ii) environments (e.g., a plant "wants to wet itself with rain and eat sun") (ecological relations).

As expected, there was a main effect for culture, $F(1,18) = 7.76$, $p < .05$, $\eta 2 = .30$, such that Ngöbe participants provided almost twice as many relational framings (M = 7.47%, SD = 3.41%) than US participants (M = 3.82%, SD = 2.37%). The same cultural trends held for both social and ecological relations separately, according to kind (see Appendix A4 for details).

(iv) Indicators of agency

Following from a focus on psychological capacities linked to having a mind, we predicted that US explanations would focus more on internalized indicators of agency by referring to (i) minds and brains, or (ii) other interior substrates (e.g., cables in robot) that underlie such capabilities. Contrary to our prediction, there was no main effect for culture on explanatory content associated with internalized indicators, $F(1,18) = .20$, ns, (US: M = .53%, SD =.50%; Ngöbe: M = .91%, SD = 2.62%).

In contrast, we expected Ngöbe explanations to focus on interactive indicators of agency by referring to (i) observable behavioral patterns as evidence of a capacity (e.g., learning from experience), or (ii) tangible means and multiple ways of expressing a capacity (e.g., barking as evidence of communication). As predicted, there was a significant main effect for culture, $F(1,18) = 9.01$, $p < .01$, $\eta 2 = .33$, such that Ngöbe participants focused more on interactive indicators (M = 1.78%, SD = .91%) than US participants (M = 0.60%, SD = .85%).

(v) Criteria for agency

If agency is understood as psychological, then we expected US participants to treat consciousness as criterial to agency by focusing on (i) self-awareness or consciousness and (ii) autonomy over own actions, distinguishing these from (iii) mere instincts or mechanistic reactions. As predicted, there was a reliable main effect for culture, $F(1,18) = 10.83$, $p < .01$, $\eta 2 = .38$, with US participants providing substantially more content associated with consciousness (versus instincts) (M = 1.31%, SD =.92%) than Ngöbe participants (M = 0.24% SD = 0.47%).

Following from a focus on relational agency, Ngöbe explanations were predicted to treat directedness as criterial to agency by focusing on (i) goal-directed needs or desires, (ii) teleological processes (e.g., "plants have the thought to grow"), and (iii) directed change or organized continuity of the entity's own states (e.g., growth, transformation, homeostasis or modulation). As expected, there was a reliable main effect for culture on directedness, $F(1,18) = 24.97$, $p < .01$, $\eta 2 = .58$, with Ngöbe participants providing much more such content (M = 4.32%, SD = 1.92%) than US participants (M = 0.93%, SD = 0.96%).

As an example of this observed cultural difference in criteria for agency, consider whether a dog is capable of communication. Many Ngöbe respondents saw the act of barking as sufficient evidence for

Table 4. Explanatory content associated with coding constructs by culture

		Percent explanatory content (across all kinds)				
		US		Ngöbe		Over
Agency framework	Coding construct	*M*	*SD*	*M*	*SD*	*M*
Anthropocentric & psychological (US)	Human-centric framing	2.66*	(1.93)	0.78*	(0.63)	1.72
	Scalar framing	6.22*	(2.54)	2.71*	(3.06)	4.46
	Internalized indicators	0.53	(0.50)	0.91	(2.62)	0.72
	Consciousness	1.31*	(0.92)	0.24*	(0.47)	0.78
Ecocentric & relational (Ngöbe)	Relational framing	3.82*	(2.37)	7.47*	(3.41)	5.65
	Interactive indicators	0.60*	(0.85)	1.78*	(0.91)	1.19
	Directedness	0.93*	(0.96)	4.32*	(1.92)	2.62
Overall content coded		16.07%	(3.43%)	18.20%	(5.10%)	17.14%

* Cultural main effect: $p < .05$ for cultural difference on that code.

the affirmative, while US participants often sought evidence of conscious intentions before making a judgment (e.g., does the dog intend to communicate a message?).

4.6. Interim summary

The coding analysis revealed distinct cultural frameworks for agency as indicated by the different sets of framings, indicators, and criteria considered relevant for agency attribution, with the exception of internal indicators of agency. US respondents were more likely to frame agency in terms of a hierarchical scale where nonhuman entities are compared against human minds. They were also more likely to treat consciousness as a criterion for agency attribution. These findings are consistent with a concept of agency as a psychological capacity tied to having a mind (as humans know it). Anthropocentric framings were significantly less pronounced in Ngöbe explanations, which instead framed agency in terms of relational capacities expressed by many nonhuman kinds. Ngöbe also relied more on interactive indicators and behavioral directedness as criteria for agency. This is congruent with a concept of agency as a relational capacity based on an ecocentric prototype that encompasses multiple natural actors. On this model, agency may be conceptualized as a capacity with many unique endpoints more akin to a heterarchical network than a hierarchical progression along the *scalae naturae* (for related observations, see Hall, 2011; Narby, 2006).

4.7. Experiment 1: Discussion

Experiment 1 revealed systematic cultural variation in agency attribution, even with modest sample sizes. We found that Ngöbe were more likely to attribute agency to plants and abiotic kinds than were US participants, who tended to restrict agency attributions to humans and animals with moderate extensions to complex artifacts, which they ranked reliably higher than did Ngöbe participants. The fact that the two groups did not differ on artifact inclusion rules out a generalized tendency for Ngöbe to attribute more agency to everything. However, we did expect that US participants would be more likely than Ngöbe to include complex artifacts in the agency domain, which we did not find in this small sample. Still, each culture's agency attribution profile for natural versus artifact non-animal kinds, although not always statistically significant, was suggestive of distinct models. Converging evidence for this proposal came from the coding analysis revealing divergent explanatory frameworks for agency. US participants tended to describe agency as a scalar, prototypically human capacity requiring consciousness, whereas Ngöbe participants tended to describe agency as a relational capacity expressed in the interactions and directed behaviors of many natural kinds.

Taken together, these results are consistent with the proposal that Ngöbe hold an ecocentric model of agency as a relational capacity, and US participants hold an anthropocentric model of agency as a psychological capacity. However, these findings are based on small samples and a limited number of capacity probes. An additional concern is that explicit verbal reports do not always align with underlying conceptual commitments, as other cultural research has shown (Astuti, 2001; Astuti et al., 2004). Stronger evidence for distinct cultural models would come from experimental manipulation of hypothesized agency frameworks, as well as a larger set of probes that can illuminate conceptual dimensions underlying agency frameworks across cultures. These were the objectives in Experiment 2.

5. Experiment 2

Experiment 2 sought to extend findings from Experiment 1 while providing additional insight into cultural concepts of agency. The first objective was to replicate the findings from Experiment 1 with larger samples (Ngöbe n = 24, US n = 35). We expected cultural differences in both inclusions and rankings for the three key non-animal kinds (plants, abiotic kinds, and complex artifacts).

Second, we introduced a new experimental condition that framed agency as a relational capacity. In the original mind-perception survey, agency predicates are presented with no grammatical object (e.g., Is x capable of feeling hunger?), which implicitly frames the capacity as a property of the individual entity (we refer to this as the original condition). The Ngöbe explanations in Experiment 1 suggested that a more culturally fluent way of reasoning about agency capacities is to include the object(s) (e.g., Is x capable of feeling hunger for food or nutrients?). Accordingly, in the relational condition we presented each agency predicate with grammatical objects that place the subject in relation to other entities, implicitly framing the capacity as a relational property. We predicted that Ngöbe would attribute greater agency to non-animal kinds (especially plants and abiotic kinds) in the relational condition as compared to the original condition, because a relational framing resonates with folkcommunication and facilitates an ecocentric perspective on agency. By contrast, we predicted that US participants would show no effect of condition (or possibly the opposite trend).[7]

Second, we selected a set of probes from the mind-perception survey to assess the two-dimensional structure of mind perception, with three probes each for the dimensions we refer to as experience and cognition (Gray et al., 2007).[8] Examining these dimensions of mind perception across cultures can offer insight into principles for inferring agency. Some researchers have argued that having internal representations is especially important for inferring capacities associated with the cognitive dimension, whereas having a body (or biological functions) is relevant for inferring experience (Knobe, 2011). If so, then this distinction can be leveraged to assess the inferential principles underlying agency frameworks. If the distinction between representational versus non-representational states is important to folkpsychology, then US participants should distinguish between cognition and experience in their attributions to non-animal kinds. But if agency is inferred on the basis of relational rather than representational grounds, then for Ngöbe this distinction should be less pronounced. Additionally, we introduced two new probes associated with animacy, life and movement, to explore relationships

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[7] On folkpsychology, a mental-state term presumably points back to the individual entity regardless of the framing: feeling hunger, and feeling hunger for food, are both contingent on the subject having a mind to process feelings. Hence our prediction. Alternatively, a stronger hypothesis could be that US participants will be less likely to attribute agency to (perceived) insentient kinds in the relational condition, because the inclusion of a grammatical object stresses the explicit contents of a mental state (i.e., its "aboutness"), inducing a representational stance on agency and thereby setting a higher standard for capacity attribution than an open-ended predicate. For example, basic experiential capacities (fear) might shift to become interpreted as cognitive capacities (fear of enemies as a mental state with specific contents). Consistent with this possibility, we found that the relational condition decreased US agency attributions to plants for 4 of 6 capacities, but these trends did not reach reliability.

[8] Gray et al (2007) refer to the two dimensions of mind-perception as experience and agency. They define agency specifically in terms of moral agency and responsibility, as distinct from the broader definition of agency we use here (namely, any entity that is perceived as capable of acting). For clarity, we refer to this dimension as cognition to distinguish it from our composite measure of agency (which includes all six capacities).

between agency and animacy concepts. We predicted that they would correspond closely for Ngöbe participants because both are premised on a common capacity to interact, whereas agency and animacy should track separately among US participants who perceive them as distinct domains (folkpsychology and folkbiology).

One additional concern from Experiment 1 is that cultural differences are due to language, given that Ngöbe interviewed in Spanish and US participants in English. To address potential language effects in Experiment 2, US bilingual Spanish-English speakers completed the task in Spanish using identical protocol to that used in Panama. We expected to observe no effects of language with respect to cultural differences.

Other methodological changes in Experiment 2 allowed us address minor questions from Experiment 1. We included a simple artifact (a tote bag) to assess notions about generic (non-computerized) artifact capacities, on the prediction that agency attributions to this simple artifact would be uniformly low across cultures. This can provide a baseline measure of non-agency, and also help rule out a positive response bias in either sample. Additionally, Experiment 2 stimuli included two non-mammal animals (a bird and frog) in addition to two of the mammals from Experiment 1 (a dog and chimp) to assess whether cultural concepts of agency differ for distinct kinds of animals. We predicted that both Ngöbe and US individuals would ascribe agency to all animals, with similar patterns of ranking for mammals (generally higher) and non-mammals (generally lower).

5.1. Participants

Participants were indigenous Ngöbe adults from the primary research community[9] (*n* = 24; 10 females) and US college students (*n* = 35; 18 females).[10] Ngöbe participants' ages ranged from 19-62 years (*M* = 37.21, *SD* = 13.93). Experience with formal schooling ranged from 0-12 years (*M* = 4.54, *SD* = 3.24).

US participants' ages ranged from 18-23 years (M = 19.00, SD = 1.26). The US students came from the same university's introductory psychology class with similar demographics reported for Experiment 1. Recruitment, community permission, informed consent, and participant compensations for each sample were conducted in the same manner as in Experiment 1.

Participants also reported their occupation, religiosity (church attendance and three belief items used in Gray et al. 2007), language identity (their first language, and language spoken with their family), and experience with nature (farming/gardening, hunting/fishing, and pet experience, and urban/rural residence). (For item details see Appendix B1; for individual differences results, see Section 5.4.)

Condition. Participants were randomly assigned to an experimental condition, with approximately half of each group assigned each to the original (Ngöbe: *n* = 12; US: *n* = 19) and the relational (Ngöbe: *n* = 12; US: *n* = 16) condition.

Language. The US sample included 11 bilingual English-Spanish speakers, all of whom completed the study in Spanish. Language could not be randomly assigned due to the small number of bilingual participants. Among the Ngöbe sample, all participants completed the task in Spanish (occasionally, Ngöbere was used for clarification purposes).

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[9] Ngöbe participants in Experiment 2 were different individuals from those in Experiment 1, with the exception of 3 participants who participated in both studies. The two experiments were conducted far enough apart that task transfers were unlikely (Experiment 1: December 2011; Experiment 2: August-September, 2014).

[10] One additional Ngöbe participant and 14 additional US participants did not complete all probes and were not included in results reporting. The greater number of incomplete tasks for US participants was due to a time constraint during one academic quarter of data collection that truncated interviews.

5.2. Methods

5.2.1. Materials and protocol

Stimuli were color photographs of 14 entities depicted on cards (4" by 4.25"), presented in random order. Entities were the same as in Experiment 1, with the addition of a bird, frog, and a tote bag (see Appendix B1). Eight capacity probes assessed three dimensions of agency: 1, cognition (communicate, memory, and morality); 2, experience (fear, pain, and hunger); and 3, animacy (alive and move). The first six probes are from the original mind-perception survey. All capacity probes were presented to all participants. Order of presentation for the animacy probes was fixed, with move always presented first as a warm-up task, and alive always presented last. Intervening probes for the six agency capacities were presented in one of two counterbalanced orders (see Appendix B1). Each experimental condition used one of two question formats (relational or original) that applied to all six mind-perception probes but not the animacy probes (see Appendix B2 for bilingual protocol).

Participants were asked to explain a subset of inclusions and exclusions on some of their capacity rankings. This was done to replicate the methods from Experiment 1, but explanations were not analyzed as part of the current experiment.

This experiment was administered as either the first or second task in a larger three-task interview (identical in the US and Panama). There were no effects of task order on agency attributions. As in Experiment 1, participants were interviewed in Spanish (Panama and US) or English (US) and interviews were audio-recorded. Also as before, the Spanish protocols were forward- and back-translated and checked for local validity by S.G.G. in Panama.

5.2.2. Data analysis

We analyzed weighted ranks as in Experiment 1, with exclusions tied for last place (range: 1 - 14). Occasionally, participants (n = 8, all Ngöbe) reported that they did not know how to respond for a particular item. These items were treated as missing data. Two Ngöbe participants (accounting for 19/25 "don't know" responses) are excluded from rank results due to substantial missing data (see Appendix B3).

5.3. Results

Our hypotheses predict the following for the key comparison set of non-animal kinds (plants, abiotic kinds, and complex artifacts): (1) Ngöbe and US participants will attribute agency differently to these three kinds on a NKM versus AKM respectively; (2) the relational framing will increase Ngöbe but not US agency attributions; and (3) the relevant dimensions of agency attribution will differ, with US participants (more so than Ngöbe) distinguishing between the two mind-perception dimensions, and Ngöbe (more so than US) coordinating their agency attributions with a third dimension of animacy. Finally, we conducted cultural consensus modeling to verify and extend the underlying conceptual models of agency implied by these results.

In testing these hypotheses we report results based on rates of inclusion rather than mean ranks. Reporting both sets of outcome measures would be redundant and inclusion rates provide the more straightforward account using standard comparative tests.[11] (Mean ranks were the object of analysis for cultural consensus modeling.) Unless otherwise noted, statistical tests were conducted with a 2 (culture) by 2 (condition: original, relational) repeated-measures MANOVA with dimension (2: cognition, experience) and kind (6: humans, animals, plants, abiotic kinds, complex artifacts, simple artifact) as

[11] All analyses reported below were also conducted for mean ranks and the story was roundly consistent with inclusions; thus, supplementary results from rank data are presented only where they clarify the main findings from inclusion data.

Table 5. Mean percent inclusions for agency[a]

	Mean percent inclusions						
	Ngöbe (n = 24)		US (n = 35)			Overall (N = 59)	
Kind[c]	M	SD	M	SD	t-test [b]	M	SD
Humans	0.95_a	(0.06)	0.99_a	(0.04)	-2.71*	0.97_a	(0.05)
Animals	0.98_a	(0.04)	0.98_a	(0.04)	*ns*	0.98_a	(0.04)
Plants	0.70_b	(0.30)	0.39_b	(0.22)	4.59***	0.52_b	(0.30)
Abiotic kinds	0.31_c	(0.30)	0.04_d	(0.06)	4.49***	0.15_c	(0.23)
Complex artifacts	$0.15_{c,d}$	(0.20)	0.24_c	(0.13)	-1.86*	0.20_c	(0.17)
Simple artifacts	0.07_d	(0.17)	0.00_e	(0.03)	*ns*	0.03_d	(0.11)

[a] Agency is a composite measure of memory, communication, morality, hunger, pain, and fear.

[b] T-tests compare mean inclusion rates across cultures for the kind in that row.

[c] Main effect for kind: Means in the same column not sharing the same subscript differ significantly at p < .05 in pairwise tests (Bonferonni-adjusted).

Note: * Indicates p < .05; ** p < .01; *** p < .001.

within-subjects variables.[12] Degrees of freedom are adjusted where appropriate using Huynh-Feldt estimates (on F-tests); or where equality of means is violated, t-tests are reported with equal variances not assumed.

5.3.1. Preliminary results

Language. Among US participants, there were no reliable effects of Spanish versus English on rates of inclusion or mean rankings for any key outcome measure (i.e., overall agency attributions, attribution by kind or experimental condition, or the separate dimensions of cognition, experience, and animacy).

Mammals versus non-mammals. Patterns of agency attribution to mammals and non-mammals (inclusions and ranks) did not reliably differ across cultures. Thus, we collapsed all four items into a single category of animals. (For additional preliminary analyses, see Appendix B4).

5.3.2. Cultural models of agency

We begin by considering cultural variability in overall agency attributions (across all six capacities). As hypothesized, we found a reliable interaction of culture by kind, $F(3.07, 165.73) = 33.1$, $p < .001$, $\eta^2 = 0.38$.[13] Across culture follow-up comparisons showed that, as predicted on an ecocentric prototype, Ngöbe were more likely than US participants to include non-animal natural kinds (plants and abiotic kinds) in their agency attributions (Plants: $t(57) = 4.59$, $p < .001$, $d = 1.24$; Abiotic kinds: $t(24.29) = 4.49$, $p < .001$, $d = 1.44$) (see Table 5). Corresponding to an anthropocentric prototype, US individuals were more likely than Ngöbe to include complex artifacts in agency attributions, $t(57) = -2.00$, $p = .05$, $d = -0.54$.

Each cultural profile of agency attribution for non-animal kinds also differed (see Table 5). Ngöbe followed the predicted NKM privileging plants and abiotic kinds above complex artifacts, as evidenced by inclusion rates and reliably differentiated in ranks (where plants and abiotic kinds are both ranked significantly higher than complex artifacts, see Appendix Table B1). Judging by inclusion rates, the

[12] In analyses that include mind-perception dimensions as a factor, some Ngöbe participants (n = 2 for ranks; n = 1 for inclusion) are excluded due to missing ("don't know") data on one dimension.

[13] In these and subsequent results, degrees of freedom are adjusted using Huynh-Feldt estimates due to violation of assumption of sphericity for kind ($\chi^2(14) = 64.91$, $p <.001$, $\varepsilon = 0.53$; and dimension by kind ($\chi^2(14) = 34.48$, $p < .01$, $\varepsilon = 0.7$).

agency domain for Ngöbe includes plants as well as animals and humans (plants were included at rates well above chance, $t(23) = 3.30$, $p < .01$). US attributions followed a partial AKM insofar as complex artifacts are accorded greater agency than abiotic kinds but not plants; this pattern was mirrored in ranks (where plants and complex artifacts are tied at a level above abiotic kinds, see Table B1). Among US participants, plant inclusion is significantly below chance, $t(34) = -2.93$, $p < .01$, indicating that plants stand farther outside the agency domain on this model. Still, it is interesting that US participants included plants at all, and did so at rates comparable to complex artifacts. This may reflect distinct notions of what plants "do" (e.g., have biological states) and what computers "do" (e.g., have representational states).

As expected, the two cultural groups did not differ in inclusion rates for animals, $t(57) = -0.44$, $p = .66$, $d = -0.12$. US participants were reliably more likely than Ngöbe to include humans, $t(35.5) = -2.49$, $p < .05$, $d = -0.73$, but this difference was of slight magnitude (mean difference = .04) and both groups were near ceiling in their attributions.

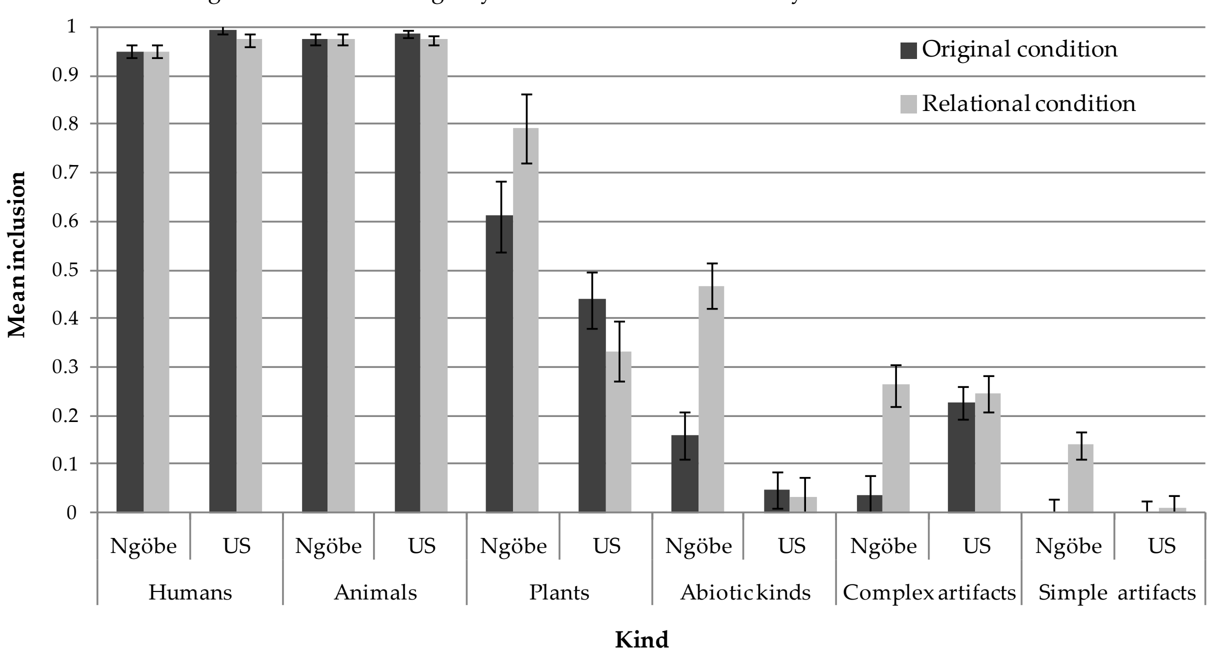
5.3.3. Experimental condition: Relational framings of agency

Ngöbe agency attributions differed more across experimental conditions than did US attributions, as indicated by the reliable 3-way interaction for kind, culture, and condition ($F(3.07, 165.73) = 5.91$, $p <. 01$, $\eta^2 = 0.10$). To further investigate these effects, we analyzed agency attributions by condition separately for each cultural group. Inclusions were analyzed with a 2-factor (condition: original, relational) repeated-measures ANOVA with kind (6) as a within-subjects variable. We continue to focus on agency as a composite variable of all six capacities, with accompanying tests of each capacity to clarify key findings.[14] We consider Ngöbe and US results in turn, which are summarized in Figure 1 (see Appendix B5 for detailed results).

Ngöbe. As expected, Ngöbe included more entities in the relational condition ($M = .60$, $SD = .15$) than the original condition ($M = .46$, $SD = .07$), $F(1, 22) = 8.78$, $p < .01$, $\eta^2 = 0.29$, and this interacted with kind, $F(2.54, 55.83) = 3.77$, $p < .05$, $\eta^2 = 0.15$. Follow-up tests confirmed that Ngöbe inclusions were reliably higher in the relational condition for abiotic kinds, complex artifacts, and simple artifacts (*ps* < or = .05). The same trend held for plants but did not reach significance ($p = .14$)

Separate analyses of Ngöbe inclusions for each capacity confirmed that the effect of condition

Figure 1: Inclusion in agency attributions for each kind by condition and culture



held for four of six capacities (*ps* < .05), with the two exceptions being morality and pain, where the same trends held but did not reach significance. This systematic pattern is consistent with the hypothesis that these capacities recruit a common conceptual framework for agency.

US. US agency attributions were unaffected by experimental condition, as indicated by the non-significant interaction of condition by kind, $F(2.22, 73.25) = 1.58$, $p = .21$, $\eta^2 = 0.05$.[15] There were no reliable differences in inclusions across conditions for any kind.

Cross-cultural comparisons. As noted above, the significant 3-way interaction of kind, culture, and condition indicated that the effect of condition varied across cultures. We analyzed cross-cultural differences for each kind across the two conditions, confirming that key differences held reliably for each non-animal kind across both conditions, with the only exception being the inclusion of complex artifacts in the relational condition (where the two groups did not differ).[16] The finding that cultural differences hold either way strengthens the interpretation of two distinct cultural models. In other words, a given framing does not appear to push one group away from an underlying "default" model that is actually shared with the other cultural group.

5.3.4. Conceptual dimensions

Next we consider whether cultural agency concepts track differently along the mind-perception dimensions of experience and cognition, and how these relate to animacy concepts.

So far we have treated agency as a unified construct, but there may also be important distinctions within this domain. As noted, prior research among Western samples has shown that folkpsychological attributions track two separate dimensions corresponding to faculties perceived as either experiential (sensory) or cognitive (representational) (Gray, et al., 2007). For example, human-made artifacts such as robots are seen as high on cognition but low on experiential capacities, whereas human infants are seen as high on experience but low on cognition. If representational capacities are a salient principle for inferring (or denying) agency on folkpsychology but not folkcommunication, then we should expect agency attribution patterns for non-animal kinds to differ on these two dimensions among US participants, but not among Ngöbe participants.

For Ngöbe, we predicted that a new dimension entirely would be relevant to agency attributions. We have thus far contrasted abiotic kinds (sun, ocean, rocks) with biological kinds (plants, animals, and humans) as if only the latter are alive, following standard Western notions. But the concept of animacy, as defined in terms of the capacity for life and movement, may tap into different conceptions across cultures. On the folkcommunication proposal, we expected Ngöbe attributions of both cognition and experience to correspond closely with animacy judgments because all three dimensions may be inferred in tandem on the basis of a capacity to relate and interact with the environment.

[15] Separate analyses for each mind-perception dimension likewise confirmed that condition did not affect either experience or cognition ranks among US participants.

[16] In both the original and relational conditions, Ngöbe were significantly more likely than US participant to include plants and abiotic kinds, *ps* < .001. In the original condition only, US participants were more likely than Ngöbe to include complex artifacts, $p < .001$. Simple artifacts did not reliably differ across cultures in either condition.

Table 7. Mean percent inclusions for cognition and experience[a]

	Cognition					Experience				
	Ngöbe (*n* = 24)		US (*n* = 35)			Ngöbe (*n* = 24)		US (*n* = 35)		
Kind	*M*	*SD*	*M*	*SD*	*t*-test [b]	*M*	*SD*	*M*	*SD*	*t*-test
Humans	0.91_a	(0.11)	0.97_a	(0.08)	-2.4*	0.99_a	(0.03)	1.00_a	(0.00)	*ns*
Animals	0.95_a	(0.08)	0.96_a	(0.08)	*ns*	1.00_a	(0.00)	1.00_a	(0.00)	--
Plants	0.59_b	(0.38)	0.35_b	(0.31)	2.62*	0.85_b	(0.22)	0.43_b	(0.30)	5.02***
Abiotic kinds	0.36_c	(0.33)	0.07_c	(0.12)	4.09***	0.28_c	(0.30)	0.01_c	(0.04)	4.43***
Complex artifacts	$0.17_{c,d}$	(0.23)	0.40_b	(0.26)	-3.36**	0.12_d	(0.21)	0.08_c	(0.15)	*ns*
Simple artifacts	0.06_d	(0.16)	0.01_d	(0.06)	*ns*	0.09_d	(0.21)	0.00_c	(0.00)	*ns*

[a] Cognition is a composite of memory, communication, and morality. Experience is a composite of hunger, pain, and fear.

[b] T-tests compare mean inclusion rates across cultures for the kind in that row.

[c] Means in the same column not sharing the same subscript differ at $p < .05$ in pairwise tests (Bonferonni-adjusted).

Note: * Indicates $p < .05$; ** $p < .01$; *** $p < .001$.

5.3.4.1. Mind-perception dimensions

As summarized in Table 7, agency attributions differed across the two dimensions for both US and Ngöbe participants, but did so in distinct ways. To follow up the reliable 3-way interaction of kind, culture, and mind-perception dimension, $F(2.79, 150.5) = 4.62$, $p < .01$, $\eta^2 = 0.08$, we explored rates of inclusion by dimension within each culture using repeated-measures ANOVAS with dimension (2: experience, cognition) and kind (6) as within-subjects variables. Each mind-perception dimension represented a composite variable of three capacities (experience: fear, hunger, pain; cognition: morality, communication, memory). As a complementary analysis, we also examined correlations between mean ranks (see Table 8) to assess the strength of relations among conceptual dimensions.

The key cultural differences in agency attribution to non-animal kinds generally held (and reliably so) across both experience and cognition (see Table 7), with the sole exception that complex artifacts were similarly low on experience for both groups ($p = .30$) (see Appendix B5). Thus, we focus on how these dimensions differed within each culture for US and Ngöbe participants in turn.

US. As predicted, US agency attributions differed across the two mind-perception dimensions, $F(1, 34) = 4.47$, $p < .05$, $\eta^2 = 0.12$, and this varied by kind $F(2.35, 79.93) = 15.36$, $p < .001$, $\eta^2 = 0.31$. Prior literature suggests that complex artifacts should be seen as having more cognitive capacities relative to experiential capacities, on the basis that computers can represent information but are not alive (Knobe, 2011). The opposite should hold for plants because they are considered alive but lacking in representational faculties. Consistent with this, complex artifacts were more likely to be included in cognition than experience (complex artifacts: $t(34) = -5.65$, $p < .001$, $d = -1.51$), as were (surprisingly) abiotic kinds ($t(34) = -3.11$, $p < .01$, $d = -0.78$). The opposite trend held for plants, which were included more often on experience than cognition, but this did not reach reliability, $p = .30$.[17]

Correlations between mean ranks for each kind were consistent with this two-dimensional structure (see Table 8). If experience and cognition represent distinct dimensions of agency for US participants, then these two sets of attributions should be extended on the basis of distinct considerations for each non-animal kind such that ranks are not reliably correlated across dimensions. As predicted, there were no reliable correlations between experience and cognition attributions for any non-animal

[17] Inclusion rates for humans and animals were also higher on experience than cognition (humans: $t(34) = 2.24$, $p < .05$, $d = 0.54$; animals: $t(34) = 2.94$, $p < .01$, $d = 0.71$), but these differences were small as attributions for both kinds were at or near ceiling.

Table 8: Intercorrelations between mean ranks across dimensions by culture

	US		Ngöbe	
Kind	Experience[a] - Cognition[a]	Agency[a] - Animacy[b]	Experience[a] - Cognition[a]	Agency[a] - Animacy[b]
	r	*r*	*r*	*r*
Humans	.43**	.55***	.56**	.42*
Animals	.05	-.02	.65***	.76***
Plants	.28	.13	.69***	.55**
Abiotic kinds	.03	-.31†	.56**	.38†
Complex artifacts	.12	.44**	.55**	.44*
Simple artifacts	-.08	.66***	.57**	.22

[a] Agency is a composite of Cognition (memory, communication, morality) and Experience (pain, hunger, fear).

[b] Animacy is a composite measure of Life and Movement.

Note: * Indicates $p < .05$; ** $p < .01$; *** $p < .001$, † indicates $p < .10$

kind among US participants (all *rs* = *ns*). Instead, cognition and experience are reliably correlated only for humans, which would be expected if humans serve as the prototype for both dimensions.

Ngöbe. We expected that Ngöbe agency attributions would not distinguish between the dimensions of experience and cognition, but Ngöbe inclusions did differ across the two dimensions, $F(1, 22) = 4.86$, $p < .05$, $\eta^2 = 0.18$, and this varied by kind, $F(3.10, 68.26) = 10.26$, $p < .001$, $\eta^2 = 0.32$. Like US participants, Ngöbe more frequently included plants in experience than cognition, $t(23) = 3.66$, $p < .01$, $d = 0.68$, whereas abiotic kinds were more often included in cognition than experience, $t(22) = -2.2$, $p < .05$, $d = -0.31$. Unlike US participants, however, there was no reliable difference for Ngöbe attributions to complex artifacts across the two dimensions, $t(23) = -1.37$, $p = .18$, $d = -0.23$.[18] Considering that abiotic kinds were high on this dimension while complex artifacts were low, it does not appear that representational principles are central on the Ngöbe framework for inferring cognition.

Although Ngöbe agency attributions did differ across dimensions, they were still closely related. Unlike the US sample, Ngöbe ranks for experience and cognition were significantly correlated for every kind, both animal and non-animal (*ps* < .05). This is consistent with our prediction that for Ngöbe, experience and cognition are inferred on the basis of similar principles.

In sum, US participants differentiated more strongly than Ngöbe participants between cognition and experience for all three non-animal kinds. Both groups shared a biology-based model for experience, but US attributions for cognition followed an artifact kinds model whereas Ngöbe followed a natural kinds model. The strongest differences on cognition emerge for distinct kinds across Ngöbe and US models (abiotic kinds versus complex artifacts), suggesting that different inferential principles are at stake in each model of agency. One relevant factor may be concepts of life, to which we now turn.

5.3.4.2. Animacy

If Ngöbe individuals see abiotic kinds as animate, then they may be using a unified conceptual model of agency that infers experience, cognition, and life on the basis of similar principles.

Cross-cultural differences. Cultural differences in concepts of animacy for abiotic kinds (sun, ocean, rocks) were dramatic. Ngöbe were far more likely than US participants to recognize abiotic kinds as alive (Ngöbe: $M = .75$; $SD = .26$; US: $M = .11$; $SD = .23$), $t(57) = 9.86$, $p < .001$, $d = 2.66$, and capable of movement

[18] As witnessed for US participants, humans and animals also differed, but again this was a minor effect with all inclusions at or near ceiling (humans: $t(23) = 3.72$, $p < .01$, $d = 1.05$; animals: $t(23) = 3.06$, $p < .01$, $d = 0.90$).

(Ngöbe: *M* = .76; *SD* = .18; US: *M* = .54; *SD* = .33), $t(54.79) = 3.26$, $p < .01$, $d = 0.79$.[19] The sun and ocean were together ranked above all other kinds on animate capacities by fully half of Ngöbe participants (11/22 for life, 15/22 for movement), in stark contrast to US participants (1/35 for life, 5/35 for movement). The fact that the sun and ocean were ranked so prominently in Ngöbe models of animacy suggests their prototypical status as animate forces. In contrast, US life attributions followed a categorical biological kinds model: plants, animals, and humans were almost always included and all other kinds excluded. US movement attributions were more graded, with abiotic kinds and complex artifacts included at levels near 50%.

Otherwise, the two groups converged on life and movement inclusions for each kind, with the only other minor difference for complex artifacts, $t(57) = -2.56$, $p = .05$, $d = -0.69$, such that US participants were more likely than Ngöbe to say that robots (but not computers) could move (US: *M* = .71, *SD* = .46; Ngöbe: *M* = .46, *SD* = .51). This could reflect different levels of familiarity with robots, and/or different interpretations of movement as autonomous versus automated.

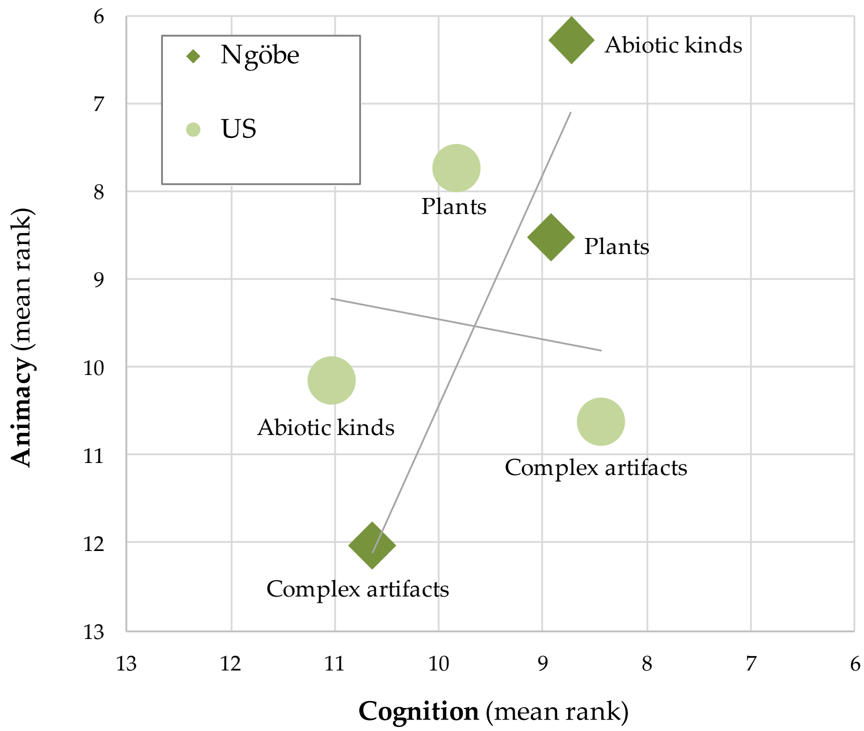
One other comparative property of life ranks should be noted. Among US participants, all living kinds (plants, animals, humans) were often ranked on a single level and everything else excluded, representing a binary concept of alive/not alive. Interestingly, Ngöbe rankings for life were just as graded as for any other agency capacity. Evidently, entities may possess distinct degrees of life force on the Ngöbe folktheory.

Animacy and agency. The proposal for folkcommunication would predict a strong relationship between animacy and agency for Ngöbe participants, insofar as both capacities are inferred from similar principles. As summarized in Table 8, Ngöbe attributions of animacy and agency were indeed reliably correlated for each kind (*ps* < .05) except abiotic kinds, which only reached marginal significance ($p = .08$). We did not expect a strong relationship for agency and animacy among US attributions given that the two constructs should tap into distinct inferential principles for folkpsychology and biology respectively. Indeed, the two constructs were reliably correlated only for humans but none of the natural nonhuman kinds. Interestingly, the two constructs were also correlated for human-made artifacts, but this is based on a small number of US respondents who attributed animacy to those kinds.

Animacy judgments are especially informative when examined in relation to cognition, as that is the agency dimension where the largest cultural differences emerged with respect to non-animal kinds. It is clear from Figure 2 that Ngöbe attributions of animacy and cognition track together across all three non-animal kinds: the more alive an entity is perceived to be, the more it is capable of cognition. In direct contrast, US attributions of cognition and animacy to these non-animal kinds bore no relationship: life and cognition were inferred independently of one another.

[19] Examining these attributions for each of the three abiotic kinds shows that Ngöbe roundly agree on the living kind status of the ocean (M = .96, SD = .20) and the sun (M = .88, SD = .34), in stark contrast to the US majority conception of these kinds as lifeless (ocean: M = .14, SD = .36; sun: M = .20; SD = .41) (*ps* < .001). Ngöbe were also significantly more likely to include the sun and ocean in movement attributions (*ps* < .05), although there was greater cross-cultural agreement on this point (Ngöbe sun: M = .96, SD = .20; Ngöbe ocean: M = 1.00, SD = .00; US sun: M = .63, SD = .49; US ocean: M = .74, SD = .44). Rocks figure less prominently in Ngöbe animacy attributions (inclusions for life: M = .42, SD = 50; and movement: M = .33; SD = .48); but this still contrasted with US participants' total denial of life to rocks (M = 0, SD = 0), $p < .001$, although movement attributions were more similar across cultures (US: M = .26, SD = .44) (p = .54). Notably, rocks still stand far above complex artifacts in Ngöbe attributions of life (M = .08, SD = .28, identical for robot and computer), which differed not at all from simple artifacts (M = .08, SD = .28). Interestingly, US participants tended to attribute life to robots (M = .14, SD = .36) and computers (M = .11, SD = .32) more often than Ngöbe participants, but these differences were not reliable (*ps* = .50 and .71, respectively).

Figure 2. Animacy & cognition: attributions to non-animal kinds by culture



In sum, these striking cultural differences in animacy concepts suggest that the Ngöbe framework for agency may be grounded in a view of life as a graded force where powerful abiotic kinds like the sun or ocean are prototypes. This contrasts with the US view of life as a binary category that is evidently based on distinct principles from those used for inferring folkpsychological (especially cognitive) agency.

5.4. Detecting multiple conceptual models without "culture"

5.4.1. Cultural consensus modeling

In this section our analysis shifts from asking what kind of conceptual model a culture has, to what kinds of cultures a model has. Setting aside any predefined cultural groupings, we used cultural consensus modeling to identify whether multiple latent conceptual models of agency are present in the dataset (collapsing across US and Ngöbe participants), and to explore between- and within-culture variations on these conceptual models. Our first objective was to determine if there are one or more consensus conceptual models. This is an important step beyond the cultural differences reported above because two groups can differ even while one group fails to converge on a consensus model (Le Guen et al., 2013). If more than one consensus is detected this will indicate that multiple coherent models are latent in the responses. Second, we are interested in the agency attribution profile of each consensus model, including which items are the most difficult to reach consensus on. Comparing these rank profiles can shed light on the conceptual frameworks and forms of competence that structure each consensus model. Third, we are interested in how participants cluster into the consensus models according to their actual cultural membership and individual characteristics, as well as how individual-level variables may predict expertise within each model. This will enrich understanding of across- and within-group variability and point to individual factors that may influence one's conceptual model of agency. Our modeling is conducted on the mean rank data in order to complement and extend the prior inclusion results.

Cultural consensus modeling (CCM) (Romney et al., 1986) has been applied extensively in prior cultural research on biological cognition (Atran & Medin, 2008; Medin et al., 2007). Conceptually similar to factor analysis, CCM determines if a single underlying model exists, as well as whether patterns of residual agreement beyond the overall consensus suggest additional models that hold for subgroups in the sample. Each participant is assigned a cultural "competence," where higher scores on a factor loading indicate that an individual's responses are closer to the cultural consensus. CCM also calculates the consensus model "answer key" with a competency weighted consensus rating for each item, providing a more reliable approximation of the common truth than traditional data aggregation techniques (France & Batchelder 2014).

Recent advances in CCM provide a model-based way to derive multicultural consensus from continuous response data (Anders et al., 2014). This new Bayesian inferential approach to consensus modeling (Anders, 2013) offers two key advantages over prior CCM techniques. 1. It treats culture as a latent variable by providing a model-based way to assess whether separate consensus models exist within a sample and to identify each participant's consensus group membership (rather than relying on known cultural membership specified in advance, as in traditional CCM methods). This confers a theoretical advantage over statistical models that treat culture as a fixed independent variable, by focusing on conceptual models and allowing cultural membership to remain latent. To emphasize this analytic distinction, we refer henceforth to "conceptual/consensus models" rather than "cultural models." 2. It introduces a new response precision parameter to assess whether some items are more difficult than others, unlike traditional CCM methods that assume all items are equally difficult. The resulting consensus model answer key accounts for variable item difficulty in addition to respondent expertise, providing a more sensitive estimate of the shared conceptual model.

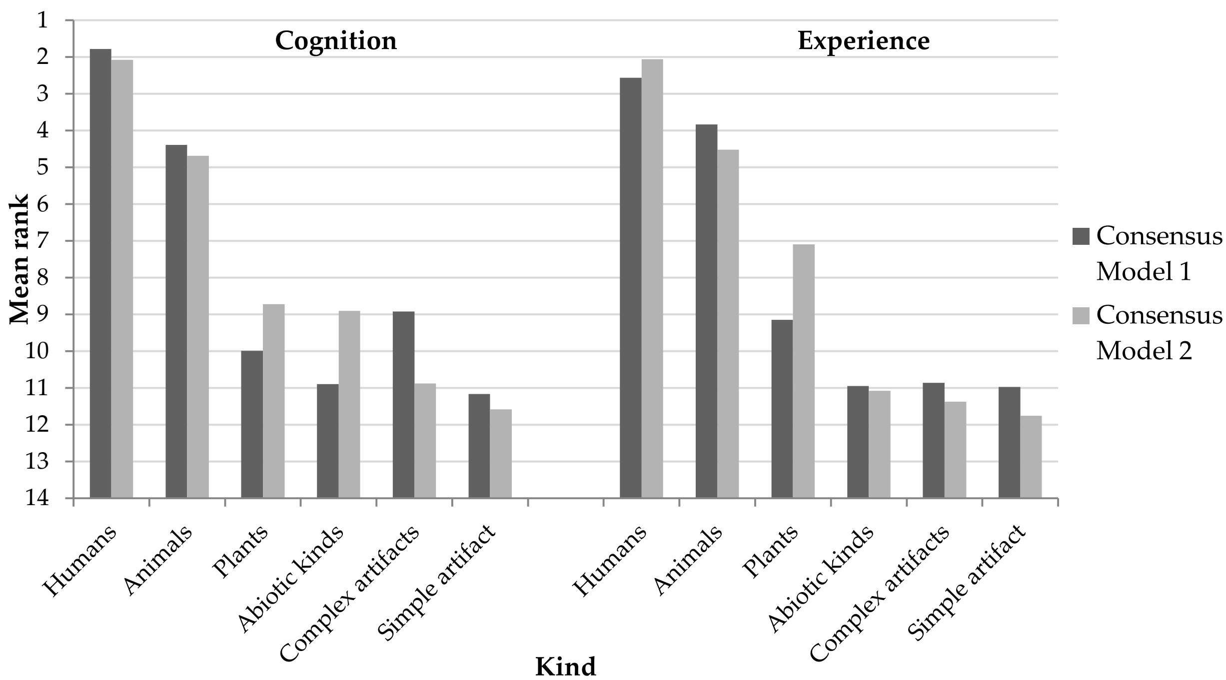
5.4.2. Methods and procedure

Using the CCTpack R software package (Anders, 2013), we applied the Bayesian CCT model to the agency ranks data (both mind perception dimensions, but not animacy capacities)[20] from all US and Ngöbe participants together (*N* = 57). The participant-level mean ranks for each kind on both experience and cognition were subjected to cultural consensus modeling at the item level (k = 14), for a 57 (participants) X 28 (14 items X 2 dimension) matrix. For ease of interpretation and consistency, results are presented at the kind level.

In CCTpack, analysis is executed by running many iterations of a given model with various parameters adjusted between models (e.g., number of derived "cultures" or consensuses, difficulty of items). Two posterior predictive checks are used to compare which model best fits the actual data. 1. To check that the consensus structure of the data is appropriately fit by the model (i.e., the appropriate number of consensuses), a scree plot of eigenvalues assesses the fit between the model-generated estimates and the actual structure of the data (see Royce, 2013 for details). 2. To check whether the item difficulty parameter should be treated as uniform (i.e., homogenous item difficulty) or variable (i.e., heterogeneous item difficulty), a variance dispersion index (VDI) reports how well the model captures differences across items due to response variability; these VDIs are compared and the model with better fit is selected (see Anders et al., 2014).

[20] CCM was conducted on the two mind-perception dimensions excluding animacy for a more conservative test of latent conceptual models, insofar as the stark cultural difference in life judgments for abiotic kinds could contribute disproportionately to detection of consensus models and membership. Nonetheless, the consensus models for experience and cognition remain virtually identical when the CCM included Alive, and membership clustering results were similar (27 of 35 US participants into Culture 1 and 21 of 22 Ngöbe participants into Culture 2).

Figure 3: Model-based consensus models for agency by dimension



Our use of CCTpack constitutes exploratory work on the capacity of the Continuous Response Model (CRM) to handle multicultural ranking data, which has not been done before. In that sense, our results contribute to the CCM literature by confirming the robustness of this model (see Appendix B6).

5.4.3. Results

5.4.3.1. Model selection and identification of latent conceptual models

The data were simulated using a series of models with 1, 2, and 3 consensuses, with and without heterogeneous item difficulty.

Item difficulty. The VDI check for item difficulty indicated that a model assuming heterogeneous (versus homogenous) item difficulty better fit the data.

Consensus fit. The scree plots of eigenvalues showed that the first factor was substantially larger than subsequent factors, with a second factor evident but less pronounced. Posterior predictive checks showed that the data structure was well fit by both a one- and two-consensus model, but a three-consensus model failed to fit the data.[21] This suggests an overarching consensus accompanied by subgroups. The overall consensus was expected due to the substantial agreement on ranks for humans and animals. A two-consensus model would be expected to pick up additional patterned variability concerning non-animal kinds. In the past, we have consistently found a good overall consensus paired with systematic subgroup differences (Medin, et al., 2007). Thus, we selected a two-consensus model with heterogeneous item difficulty.

5.4.3.2. Consensus Models

The model identified two consensuses latent in the agency rank responses (see Figure 3). The two consensus models that emerged were consistent with hypothesized frameworks for ecocentric versus anthropocentric agency. The items that are in largest disagreement between the two models are non-

[21] A 3-consensus model was unable to reach convergence of modeling chains (Anders, 2014), indicating that there were no detectable third components and/or too many degrees of freedom.

animal kinds, reflecting that plants, abiotic kinds, and complex artifacts were organized differently across the two consensuses. The first consensus model for agency fit an artifact kinds model (AKM) for cognition (complex artifacts were ranked above both abiotic kinds and plants), but experience followed a biology-based natural kinds model (NKM) (plants ranked above both complex artifacts and abiotic kinds). The second consensus model followed a NKM for both cognition and experience, with cognition relatively ecology-based (abiotic kinds and plants ranked together above complex artifacts) and experience relatively biology-based (plants ranked higher than both abiotic kinds and complex artifacts). Comparing the two consensus models, cognition is where the more pronounced differences arise. Model 1 appears to treat cognition as a property of information-processing artifacts (only), whereas Model 2 treats cognition as a property of all natural kinds but not artifacts.

Item difficulty. We used item difficulty results to illuminate the forms of competence associated with each conceptual model. One unique strength of CCM is that it goes beyond sample means to assess each individual's level of competence on the consensus model. CCTpack improves on this feature by analyzing item difficulty for each item in the model. The most difficult items are the hardest to reach consensus on, and so can be used to distinguish more from less competent members of a consensus group.[22]

On Model 1, complex artifacts and humans were the most difficult item kinds for cognition, such that greater competence was correlated with higher rankings for complex artifacts (r = -.35, $p <$ .05) and lower rankings for humans (r = .34, $p <$ .05), indicating that these two kinds shifted places near the top of rank hierarchies depending on competence.[23] For experience, humans and animals were the most difficult items, such that those with greater competence ranked animals lower (r = .38, $p <$ .05) and tended to rank humans higher (r = -.28, p = .08).[24] On Model 2, abiotic kinds and humans were the most difficult item kinds for both cognition and experience. Greater competence was correlated with ranking abiotic kinds higher (*rs* = -.90 and -.67 for experience and cognition respectively, *ps* < .001) and humans lower (*rs* = .53 and .49, *ps* < .05), indicating that these two kinds shifted places near the top of rank hierarchies depending on competence.

These results suggest that the two consensus models represent qualitatively distinct forms of reasoning about agency. For the anthropocentrically oriented Model 1, competence means an increased recognition of complex artifacts' capacity for cognition, coupled with lower estimation of animals' capacity for experience. For the ecocentrically oriented Model 2, competence means greater appreciation of both the cognitive and experiential capacities of abiotic kinds like the sun and ocean.

5.4.3.3. Consensus model membership

These item-specific differences in competence motivate further questions concerning individual and conceptual variability in consensus model membership, both across and within the two models.

Consensus group membership. The model detected and clustered individual participants into the two consensus models in close correspondence with actual cultural membership. The majority of US participants (31 of 35) were clustered with Model 1, and the majority of Ngöbe (14 of 22) with Model 2. It is notable that US participants clustered so strongly into a single model despite being the larger sample and being drawn from two distinct language samples (monolingual and bilingual). The Ngöbe sample

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[22] This interpretation of item difficulty builds on the property of the CCM model that in general, more competent respondents will tend to get the hard items correct more frequently than less competent members.

[23] Recall that ranks are reverse scored, hence the negative correlation between expertise and higher ranks.

[24] In practice this often meant that Model 1 experts increased the distance between humans and animals in their experience rankings, relative to less expert participants. Interestingly, the specific items of highest difficulty from the animal category were the bird and frog, consistent with an anthropocentric model that places mammals closer to the human prototype than non-mammals.

exhibited more clustering variability, which may speak to the presence of multiple cultural models of agency.

Individual differences in consensus model membership. Ngöbe. The clustering results indicate substantial within-culture variability among Ngöbe. Based on prior research, we anticipated that Ngöbe members of the ecocentric Model 2 would also lead more traditional community-based lifestyles, as indexed by five measures (livelihood, Indigenous church membership, age, language identity, formal schooling). Of these variables, livelihood and language identity reliably distinguished between Ngöbe clustered with Model 1 and Model 2. Members of Model 2 were comparatively more likely to be engaged in subsistence activities versus externally organized occupations (e.g., wage-earning work), $F(1, 19) = 4.28$, $p = .05$, $\eta^2 = .18$, and to identify Ngöbere as their primary language rather than Spanish, $F(1,19) = 9.90$, $p < .01$, $\eta^2 = .34$.[25]

Model 2 members were also more likely to be in the relational condition, $F(1, 19) = 7.80$, $p < .05$, $\eta^2 = .29$. If the ecocentric Model 2 reflects a conceptual orientation widely available in the Ngöbe community, as we propose, then this could be interpreted as further evidence that the relational framing of agency facilitated that framework. At the same time, the characteristics of Model 2 may also be partially due to the experimental condition. Sample sizes do not permit us to factor out the influence of condition on consensus models (*n*s are too small for a 2-culture model fit in each condition separately).

US. Among US participants, there were no reliable differences between participants clustered with Model 1 versus Model 2 for experimental condition, task language, or individual characteristics. This analysis, however, is limited by the small number of US participants clustered with Model 2 ($n = 4$).

Conceptual differences in cross-model membership. Given that a cultural majority emerged for each conceptual model, we were interested in the responses of those individuals who were cross-clustered with the other consensus model (i.e., that of their non-majority culture). The agency attribution profiles of these subgroups could speak to what happens at the boundaries of each conceptual model. All differences reported below were significant at the $p < .05$ level in MANOVAs (either by culture or model membership) comparing agency attributions for cognition and experience.

US participants who clustered with the Ngöbe-majority Model 2 differed from their US Model 1 counterparts in their treatment of plants (more experience and cognition) and complex artifacts (less cognition). They remained distinct from Ngöbe members of Model 2, however, in their rejection of cognition for abiotic kinds. Ngöbe participants who clustered with the US-majority Model 1 diverged from their Ngöbe Model 2 counterparts in their attributions to plants and abiotic kinds (less agency to both, which held at or near significance for both experience and cognition). However, they remained distinct from US members of Model 1 by attributing more cognition to abiotic kinds and less cognition to complex artifacts.

These findings suggest that the general view of agency among US individuals seems to afford variation towards a solidly biology-based model that encompasses all living kinds but rejects anything considered inanimate. Conversely, the general Ngöbe stance on agency affords variation toward a more animal-centric model where the agency of non-animal natural kinds is relatively diminished.

Individual differences in within-group competence. We next analyzed individual differences associated with competence scores, which indicate how well an individual fits the consensus model to which they were assigned. Analyses were run separately for Model 1 and Model 2 scores within each cultural group (Ngöbe or US) given that demographic features were hardly comparable between groups.

Ngöbe. We anticipated that competence scores for Ngöbe participants clustered with Model 2 ($n = 14$) would correlate with more traditional Ngöbe lifestyles, given that this model reflects an ecocentric orientation to agency. Indeed, greater competence was reliably correlated with greater age ($r = .64$, $p < .05$), less formal schooling ($r = -.73$, $p < .01$), and, unexpectedly, gender (males more expert, $r = .57$, $p <$

[25] Due to missing demographic information, Ngöbe $n = 21$ for these analyses.

.05). This supports the idea that the ecocentric model of agency is facilitated by greater engagement with Ngöbe cultural knowledge (e.g., being an elder) and/or less involvement with non-Ngöbe cultural discourses. There were no reliable correlations between competence and individual characteristics among Ngöbe clustered with Model 1 (n = 8), but the modest sample size limited this analysis.

US. We had no hypotheses concerning individual predictors of competence scores among US participants, beyond the possibility (based on prior pilot work) that religious belief or experience with nature may be relevant to notions about plants. Among US participants clustered with the anthropocentrically oriented Model 1 (n = 31), grade level was positively correlated with greater competence ($r = .37$, $p < .05$). This may suggest that university schooling (possibly psychology-specific, given that these participants were drawn from a psychology subject pool) strengthens the dominant cultural model of agency. Unexpectedly, competence for US members of Model 2 (n = 4) was *negatively* related to religion (in contrast to our prior pilot work), such that those reporting fewer religious beliefs were more competent ($r = -.96$, $p < .05$).[26] The small sample prohibits firm conclusions, and both these relationships should be interpreted with caution given the lack of predictions.

5.5. Experiment 2: Discussion

Two distinct cultural understandings of agency are evident in these results. The Ngöbe model offers an ecocentric perspective on which plants and abiotic kinds are both significantly more agentic than complex artifacts, and plants in particular figure as robust agents. In contrast, on the US model the domain of agency appears to include only humans and animals as agents proper, while complex artifacts are significantly more agentic than abiotic kinds and on par with plants. US results held across Spanish and English task versions so these cross-cultural results do not simply reflect cross-linguistic differences.

To test our proposal that these agency attribution models point to distinct grounds for inferring agency, we introduced an experimental manipulation and also probed the conceptual dimensions underlying agency attribution. The relational framing of agency facilitated greater agency attributions for Ngöbe participants only, indicating that relational principles are important to inferring agency on this cultural model. Further evidence for diverse inferential principles came from analysis of conceptual dimensions underlying cultural models of agency. Both groups shared a similar biology-based model of experience, but the dimension labeled cognition taps into distinct attribution profiles across cultures: an information-based view of cognition as potentially separable from animacy (US), or an ecology-based view of cognition as closely linked to animate force. US results especially were consistent with a two-dimensional mind-perception framework where agency is conceptualized according to experiential or cognitive capacities, and cognition in particular is decoupled from animacy judgments. The experience-cognition distinction was less pronounced for Ngöbe participants and both dimensions tracked together with a third dimension of animacy.

Cultural consensus modeling allowed us to identify two conceptual models from the overall data while treating culture as a latent variable, and to analyze the conceptual properties and individual characteristics associated with each consensus model. Three key findings emerge. 1) Beyond the overall agreement on the agency of animal kinds, two separate consensus models were detected, confirming that the ecocentric and anthropocentric models of agency represent separate coherent bodies of conceptual knowledge about non-animal kinds. 2) Forms of competence associated with each model provided converging evidence for the hypothesized conceptual frameworks in terms of conceptual content (items that predicted competency on each model were either computerized or abiotic natural kinds) and individual variability (with competence associated with either university schooling or traditional cultural engagement). 3) Modeling results suggest that there are multiple conceptual models of agency available

[26] Religiosity was a composite measure of the three religious belief items, see Appendix B1.

in the Ngöbe community, with the more pronounced cultural model being an ecocentric model of agency. The US sample reached strong convergence on a single dominant model of anthropocentric agency.

6. General discussion

Across two experiments, converging measures paint a robust picture of distinct cultural frameworks for understanding agency. Findings consistently presented two different agency attribution profiles wherein Ngöbe were more likely to attribute agency to plants and abiotic kinds than US college students, who in turn were more likely to attribute agency to complex computerized artifacts.

We argue that these disparate models point to culturally diverse grounds for inferring agency as a relational capacity understood on an ecocentric prototype (folkcommunication), or as a psychological capacity understood on an anthropocentric prototype (folkpsychology). The current experiments provided several sources of evidence to support this proposal. First, coding analysis of explanations showed that US participants interpret agency as a scalar, prototypically human capacity requiring consciousness. Ngöbe instead interpreted agency in terms of directed interactions with environment and others, indicating a concern for the relational dimensions of agency. Second, by introducing a relational framing of capacity probes, we demonstrated that Ngöbe (but not US) agency attributions are facilitated by a relational perspective, consistent with the claim that the capacity to relate is a grounding principle for inferring agency on folkcommunication.

Third, the conceptual organization of agency dimensions differed across cultures. US attributions suggested a nested domain-specific approach whereby animacy followed a wide biology-based model, experience followed a narrower biological model that mostly excluded non-animals, and cognition followed an artifact-kinds model that included computerized artifacts as well as animals. That US models diverged across these dimensions indicates that distinct inferential principles are at stake in these domains, and cognition especially points to an anthropocentric framework where agency is understood as a representational property on a human prototype. By contrast, the conceptual organization observed for Ngöbe agency attributions presents a more unified framework for agency. All three dimensions fit an overarching natural kinds model, under which experience was more biology-based while cognition and animacy were more ecology-based. This suggests that for Ngöbe the grounding principles for inferring agency are similar for all three domains, consistent with our proposal for folkcommunication where agency is based on a capacity to relate.

Finally, we consolidated these findings by using a recently developed method for analyzing cognitive variability through a hierarchical Bayesian inferential approach to cultural consensus modeling. With culture treated as a latent variable, these bottom-up modeling results confirmed that the observed differences in agency attribution arise from two distinct bodies of consensus knowledge, rather than deviations from a single model. The two consensus models were consistent with the hypothesized anthropocentric versus ecocentric prototypes for agency. Individual membership on each consensus model largely clustered with actual cultural membership, while at the same time highlighting cross- and within-culture variability in conceptual models and forms of competence. Ngöbe participants appear to have access to multiple models of agency as ecocentric (the more pronounced cultural model) or relatively animal-centric, while US participants reach strong consensus on a single model of agency that reflects an anthropocentric orientation.

Limitations

Before discussing the implications of these findings we address potential limitations. One potential concern arises with our experimental condition. Perhaps by including an object following a capacity predicate in the relational condition, we implied that the capacity in question properly applies to the subject (e.g., asking if plants can feel hungry for nutrients may imply that plants can feel hunger), and perhaps Ngöbe participants are more sensitive to this implicature than US participants. Even if this were the case, the key predicted cultural differences also hold for the original condition so this would not explain away our results. More to the point, however, we would argue that this pragmatic implicature (such as it is) is conceptually aligned with our argument for a relational agency framework. If one's focus is on the interaction between subject and object, then agency predicates do in fact play a conceptual role of binding two entities in a particular kind of relationship (see also Knobe & Prinz, 2008). To the extent that the predicate-object pairing accentuates the relational aspect of agency, we interpret this as a meaningful property of a folkcommunication framework.

Another remark involves the presence of multiple models in the Ngöbe sample. One consideration is that this finding may reflect the greater range of individual differences among the Ngöbe sample (age, schooling, etc.) and our US college student participants were simply too homogenous to yield multiple models. It is certainly plausible that all communities have access to multiple models of agency and we do not wish to suggest that all US individuals conform to a single agency framework. However, our US participants did vary on potentially important characteristics such as bilingualism, religiosity, and experience in nature, but they nonetheless presented a single dominant cultural model. This raises important questions for further research concerning the kinds of variability that can support the presence of multiple models within a community. For instance, it would be informative to explore diverse US samples beyond the college classroom and Western samples beyond the US, as we are currently doing in follow-up research.

Finally, another potential concern is that differential familiarity with complex artifacts (robots and computers) may explain the observed differences between Ngöbe and US attributions to these items. These cross-cultural differences were most evident on the cognition dimension, and we interpreted this to indicate that Ngöbe and US infer cognition based on distinct principles.[27] But it is important to consider whether this could instead reflect different knowledge about such artifacts. In fact, complex artifacts (cell phones, radios, and increasingly televisions and computers) are now common in the Ngöbe community although certain individuals such as elders or subsistence farmers may use them less frequently. This points to the larger issue that familiarity with complex artifacts is itself a cultural factor that may relate to any number of lifestyle choices. While further research could investigate the extent to which familiarity with complex artifacts entails differences in agency attribution, our two national samples differed in many other ways including formal schooling, economic status, and (presumably) personal familiarity with plants and non-urban ecosystems. Each factor reflects and reinforces cultural epistemologies, including beliefs about agency, and a research agenda that aims to "parcel out" all such differences in this manner risks losing sight of what is at stake.

Given the complexity of cultural systems, it may not be feasible (or desirable) to isolate one factor and give it explanatory priority in a system where many variables interrelate with one another and epistemological orientations. For this reason, consensus modeling can be a useful tool to highlight how distinct conceptual models arise in a larger sample while refraining from categorizing individuals into a priori cultural categories. This approach allowed us to focus on latent differences in conceptual models and explore multiple forms of variability within and across those models. Indeed, we found that lifestyle factors do cluster together in ways that converge predictably with forms of competence on a given consensus model of agency. If we assume that culture is a complex system, then such findings can offer insight into the factors that contribute to diverse ways of organizing conceptual knowledge, rather than serving as nagging confounds that detract from understanding of "pure" cultural differences.

[27] In fact, the results for complex artifacts remain somewhat inconclusive. In Experiment 2, we observed a reliable trend for US participants to attribute greater agency to complex artifacts as compared to Ngöbe. However, Experiment 1 findings for complex artifacts were mixed (US rankings were higher as expected, but inclusions were similar across both groups). Further work is needed to clarify the extent of the difference.

Interpretation of cultural differences

There are several layers of cultural variability evident in these findings, which present multiple potential interpretations of cultural difference. Taken alone, the findings for agency attribution profiles could be consistent with an overextension account on which the two cultural groups mobilize a similar (universal) concept of agency but simply extend it at different rates to different non-animal kinds. On this account, one could argue that Ngöbe versus US frameworks carve out agency domains that are nested sets—with one cultural framework more restrictive than the other, or one framework overextended relative to the other—rather than tapping into distinct frameworks.

However, this account is inadequate to explain the full picture of results. For one, the findings for complex artifacts versus natural non-animal kinds go in opposite directions across cultures. For another, our results point to distinct organization of agency concepts across the conceptual dimensions of experience, cognition, and animacy. Both findings challenge a simple over- or under-extension account by pointing to more complex forms of diversity. Furthermore, participants' own explanations attested to different forms of explicit reasoning about agency, and the importance of relational reasoning to the Ngöbe framework was confirmed experimentally through a subtle framing manipulation. Finally, a bottom-up approach to consensus modeling identified two distinct and coherent patterns of reasoning in these cross-cultural responses, rather than a single model accompanied by deviations. The evidence considered as a whole lends itself most readily to the interpretation that different principles for inferring agency are at stake.

More specifically, these findings are consistent with our hypotheses concerning cultural diversity in the conceptual structure of the agency domain. For US individuals, the overall picture suggests a domain-specific profile that holds animate kinds and psychological kinds in different (but overlapping) categories, and infers folkpsychological agency differentially on the basis of either a biological capacity for experience or a representational capacity for cognition. For Ngöbe informants, the overall picture suggests an integrated conceptual framework that holds diverse natural kinds under a common domain of folkcommunicative agency, and infers a variety of agency capacities (i.e., experience, cognition, animacy) on the basis of similar principles—principles that we propose are fundamentally relational in nature. Ngöbe conceptual models and explanatory frameworks challenge the idea that agency concepts are universally structured around a concern for minds as distinct from their embodied interactants.

Interestingly, a sizable minority of US respondents were willing to ascribe experiential capacities to plants. This suggests a more expansive appreciation of sentience than one strictly tied to having a brain, although prior research based on domain-specificity theory has rarely considered this possibility (or considered it a surprise when results indicated such) (e.g., Arico et al., 2011; Opfer & Gelman, 2001).

These findings raise a wealth of questions about the interaction of agency concepts and broader cultural systems (ojalehto & Medin, 2015). For instance, one might speculate that the US folkpsychological stance on agency is tied to a heightened focus on (human) minds under Cartesian dualism, whereas the Ngöbe ecological stance on agency partakes of a cultural worldview that sees humans as part of nature (Kimmerer, 2013; Medin & Bang, 2014). In fact, Western researchers working from an anthropocentric folkpsychology may have mischaracterized indigenous concepts by claiming that they represent a supernatural or anthropomorphic overextension of (human-like) mental-state concepts to non-animal kinds. If one is not working from a human psychological prototype, then the view that plant behavior (for instance) reflects intentional agency is quite plausible. Indeed, this is precisely the message offered by an increasing body of scientific evidence for the intelligent behavior of plants, bacteria, and other natural kinds, including even some abiotic forces (Calvo & Keijzer, 2011; Chamovitz, 2012; Haila & Dyke, 2006; Kauffman, 2008; Marder, 2013; Narby, 2006; Trewavas, 2016). Furthermore, our proposal that such forms of agency may be interpreted under a folkcommunication framework builds on mounting research that shows how people—including typical Western samples—organize conceptual knowledge around relational categories and social dimensions of agency (e.g., Hirschfeld, 2013; Luhrmann, 2011; Mascaro & Csibra, 2012; ojalehto, et al., 2013; Tamir, et al., 2016).

7. Conclusion

We have argued that Ngöbe individuals hold a conceptual framework for agency that is fundamentally geared toward understanding interactions and relationships, which differs from the US folkpsychology focused on internalized mental states. Our findings suggest that grounding principles for inferring agency diverge across cultures, leading to agency attribution models that cut across different domains and track different conceptual dimensions rather than fitting a neat "animistic" overextension account of folkpsychology to non-animal kinds. While an emphasis on psychological agency as distinct from other (biological, physical) forms of agency has been widely assumed to be a conceptual prior, these findings suggest it may instead be a feature of Western cultural epistemologies.

The implications of our account are potentially far-reaching, given that agency concepts play a fundamental role in cognitive processes ranging from causality and mind perception to morality (e.g., Banaji & Gelman, 2013). The present research offers a novel perspective on the universality of domain-specific folktheories for agency and resonates with calls to reevaluate the privileged role of mentalistic folkpsychology in social cognition (Heyes, 2014; Hirschfeld, 2013). Furthermore, human-nature relationships are currently under tremendous stress as a result of Western worldviews and ways of interacting with the rest of nature (Kahn et al., 2010; Mace, 2014). Ngöbe perspectives could be extremely useful in offering a way to understand agency based on an ecologically inclusive principle of relational capacity, providing a complementary perspective to the common Western narrative of human-centered agency. Given that our intuitive recognition of other kinds as agents helps to shape their role in our social and moral communities, it seems well worth exploring a conceptual framework for ecocentric agency.

Acknowledgements

For comments and conversations about ideas presented in this article, we are thankful to Sonya Sachdeva, Rumen Iliev, Sandra Waxman, Rebecca Seligman, Jeremy Narby, Eugene Anderson, Scott Atran, Joshua Knobe, Fernando Santos-Granero, Lance Rips, Ara Norenzayan, Olivier Le Guen, Jonas Nagel, the late Philip Young, and fellow Mosaic Lab members. For statistical and programming contributions, we thank Royce Anders, Pascal Paschos, and Satoru Suzuki. Versions of this article were presented at ZiF research group on the Cultural Constitution of Causal Cognition, CogSci Meetings, and the Society for Anthropological Science. This work was supported by a DRMS Doctoral Dissertation Research Improvement Grant 1427035 and National Science Foundation grants SES0962185 and DRL1114530 and AFOSR FA9550-14-1-0030.

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APPENDICES

Appendix A: Experiment 1

A1. Methods and procedure

The present task was adapted from the original mind-perception survey in several ways: (1) Response method was ranking rather than pairwise comparisons; (2) Items included plants and abiotic kinds in addition to selected original items; (3) Only a subset of capacity probes was used; and (4) Verbal explanations were elicited.

Stimuli: Two special agents (God, deceased human) were included in the stimuli but not reported here as they are irrelevant to the current question. Stimuli also included a frog in the US but not in Panama (only 2 Ngöbe participants saw the frog), so this item is excluded from ranking results. (Note: Four US interviews had either or both rain and rock as missing items. These were treated as missing but the rank order still included them in the tie for last.)

Rankings: To keep interviews of reasonable duration, each participant ranked 2-4 capacities. The number of capacities ranked did not differ significantly across groups (Ngöbe M = 2.81, US M = 3.18, $t(20) = -1.05$, *ns*). Each capacity was ranked by a similar number of Ngöbe and U.S. respondents, $\chi 2$ (1, N = 22) from 0.00 to 1.70 for each capacity, all ns. The order for the capacity probes was random, except that *communication* usually appeared first in Panamanian interviews because pilot work suggested its centrality for Ngöbe. (Note: 8 of 11 Ngöbe saw Communication first; 4 of 11 US students saw Communication first. This difference in distribution is not significant. The other 4 capacities were presented in random order for both groups.)

Explanation probes. Participants generally provided one explanation per entity (e.g., chimp) or kind (e.g., all animals), with number of explanations provided for a given capacity ranging from 2 to 19. Average length of explanation did not vary by culture (Ngöbe M = 11.17 words, SD = 2.30; US M = 12.04 words, SD = 2.01, t(20) = .-.94, ns); nor did the average number of explanations provided by individual participants (Ngöbe M = 20.18, SD = 10.19; US M = 19.64, SD = 8.39, t(20) = .14, ns).

Bilingual protocol

Probe stem, for Communication: I will ask you to decide which thing is more capable of [conveying thoughts or feelings to others]. Please look at all the things here, then rank them in order of top to bottom, from those who are most capable of [conveying thoughts or feelings to others], to those who are least capable.” *Voy a pedirle que decida, ¿Cual cosa es más capaz de [expresar pensamientos o sentimientos a los demás]? Por favor, mire a todos los cosas aquí, y ordénelos desde los más capaces [de expresar pensamientos o sentimientos a los demás] hasta los menos capaces.*

Desire. Which thing is more capable of longing or hoping for things? *¿Cual cosa es mas capaz de desear o esperar las cosas?*

Thought. Which thing is more capable of thinking? *¿Cual cosa es mas capaz de pensar?*

The remaining bilingual probes were identical to the Protocol used in Appendix B2 (without the relational condition).

A2. Detailed results: Agency attributions

Other effects. As expected, there were also significant main effects of culture and kind on both inclusions and rankings. Overall, Ngöbe included more entities in their agency ranks (M = 0.66, SD = 0.20) than did US participants (M = 0.45, SD = 0.15), $F(1, 20) = 7.82$, $p < .05$, $\eta^2 = .28$. Overall mean ranks also differed slightly (Ngöbe: M = 8.88, SD = 0.22; US: M = 8.66, SD = 0.16), $F(1, 20) = 6.69$, $p < .05$, $\eta^2 = .25$. They are not exactly equal across groups because mean ranks are aggregated by kind, leading to a weighted mean rank. Overall mean rankings are identical when averaged across the 16 items individually for an unweighted average of 8.5. There were main effects for kind on both inclusions, $F(3.24, 64.87) = 61.48$, $p < .01$, $\eta^2 = .76$, and rankings, $F(3.47, 69.35) = 114.41$, $p < .01$, $\eta^2 = .85$. Humans and animals were included more than the other three kinds, (*ps* < .05), with humans ranked highest followed by animals (*ps* < .05), and then the three non-animal kinds, which did not differ from one another (these differences are noted with subscripts in Table 1 in the main text).

A3. Coding scheme for explanations

Table A1: Inter-rater reliabilities for coding variables

	Inter-rater reliability tests	
Coding variable	**Alpha**	**ICC***
Framings of Agency		
Human-centric framing	0.81	0.69
Scalar framing	0.81	0.69
Social relations framing	0.92	0.85
Ecological relations framing	0.88	0.79
Agency Constructs		
Internalized indicators	0.86	0.76
Interactive indicators	0.83	0.70
Consciousness criteria	0.87	0.77
Directedness criteria	0.77	0.62
Individual Processes	0.88	0.79

* All ICC tests are significant, p < .01, with 232 degrees of freedom

A4. Detailed Results: Explanatory frameworks for agency

Explanation corpus: The final data set included a total of 429 explanations from 20 participants across the five agency capacities and five kinds. *Agency capacities:* The cultural distribution of explanations provided for each capacity did not vary by culture (overall explanations per capacity: Thought, 64; Communication, 151; Morality, 62; Hunger, 79; Desire, 73). *Entity kind:* The number of explanations provided for each kind did not differ by culture. There was a reliable main effect of kind, $F(1,18) = 15.77$, $p < .01$, $\eta^2 = .47$, with more explanations provided for animate kinds (M = 14.20, SD = 6.40) than inanimate kinds (M = 7.25, SD = 5.14). There was no interaction of culture by kind.

Coding capture. Coding capture refers to the portion of the total explanatory content provided by individuals that was captured by the coding scheme. There was no main effect of culture on coding capture (Ngöbe M = 18.20%, SD = 5.10%; US M = 16.07%, SD = 3.41%, $t(18) = 1.10$, ns), indicating that the coding scheme successfully captured modes of reasoning relevant to both groups.

Detailed results for key coding constructs.

Relational framings of agency: Broken down by social and ecological relations. Overall, Ngöbe relied on relational framings of agency (social + ecological) significantly more often than US participants. The same cultural trend held separately for social relations, $F(1,18) = 4.78$, $p < .05$, $\eta^2 = .21$, and non-significantly for ecological relations, $F(1,18) = 2.95$, $p = .10$, $\eta^2 = .14$. Our coding system followed the Western sense of "social" so the distinction between social and ecological depended on the grammatical subjects (animate or inanimate). Thus, it is unsurprising that there was a main effect of kind $F(1,18) = 6.50$, $p < .05$, $\eta^2 = .27$, such that explanations for animate kinds had more social relational content (M = 3.52%, SD = 3.13%) than explanations for inanimate kinds (M = 1.62%, SD = 2.15%). And vice versa, inanimate explanations had more ecological relational content (M = 5.26%, SD = 4.29%) than animates (M = .90% SD = 1.47%), $F(1,18) = 19.79$, $p < .01$, $\eta^2 = .52$. No interactions of culture by kind were found for either category.

Appendix B: Experiment 2

B1. Methods and procedure

Items: Simple artifact: In Panama, the simple artifact was a handmade net bag. In the US, it was a standard (industrially-manufactured) tote bag. This difference between the two artifacts had no discernable effects on results—capacity attributions to the bag were uniformly low for both Ngöbe and US participants.

Counterbalanced probe orders: (Order A) Move, morality, fear, memory, communication, hunger, pain, live; *(Order B)* Move, pain, hunger, communication, memory, fear, morality, live.

Experimental condition: In the relational condition, each capacity probe identified an object (or objects) of the agency predicate (e.g., can x feel hunger for *food or nutrients*?). Each probe was always presented with the focal objects noted in the protocol below; other objects were occasionally used if further examples were needed. Every participant in the relational condition heard the initial probe for a capacity in the relational format. However, the total number of relational probes given by the experimenter during the rest of the ranking process varied across participants due to interview dynamics (e.g., some participants sorted rapidly, requiring fewer experimenter probes overall and thus receiving fewer relational probes).

Demographic items: Religiosity: In addition to reporting church attendance, participants responded to three belief questions drawn from the original mind-perception survey of Gray et al. 2007: 1) I consider myself to be strongly religious [or spiritual] / *Yo me considero muy religioso [o espiritual];* 2) I believe that God exists / *Yo creo que Dios existe;* 3) I believe that people whose bodies are dead continue to live on spiritually / *Yo creo que las personas cuyos cuerpos están muertos, siguen viviendo espiritualmente. Experience with nature:* In addition to reporting their place of primary residence in childhood (urban, suburban, rural), participants responded to the following questions about experience with nature: 1) Do you [your parents] have a farm or garden? / *¿Tiene[n] [sus parientes] una finca o un jardín?* 2) In general, I would say that my experience with planting, farming, or harvesting is: [5-point response scale] / *En general, yo diría que mi experiencia con la siembra, la finca, o la cosecha es:* 2) In general, I would say that my experience with hunting and fishing is: / *En general, yo diría que mi experiencia con la caza y la pesca es:* (same scale) 3) Do you have a pet now [have you ever in your life]? *¿Tiene una mascota, ahora [en tu vida]?*

B2. Bilingual protocol

Instructions: In this task, we will ask you different kinds of questions. There are no right or wrong answers; please respond with your thoughts.

> *En esta tarea, te vamos a preguntar diferente tipos de preguntas. No hay respuestas correctas ni incorrectas. Puedes responder como piensas.*

Practice task: Okay, let's start by practicing some questions to see the task goes. First, we'll practice ranking. The example is size. So the question is: Decide which of these is the biggest.

> *Vamos a empezar con unas preguntas de practica para ver cómo va ser la tarea. Primero vamos a practicar clasificación. El ejemplo para practicar es el tamaño. Entonces, la pregunta es: ¿Cuáles cosas son más grande?*

Bilingual Questions, for Original & [Relational] Conditions

General question stem: Which things are most capable of [X]? Please consider each thing and rank them in order of top to bottom, from those who are most capable of [X], to those who are least capable. If some of them are equal, you can put them together in the same row. If some of them don't have any capacity to do [X] at all, you can leave them out.

> *¿Cuáles cosas son mas capaz de [x]? Por favor, mira todas las cosas aquí, y ordénelas desde arriba hacia abajo las que son más capaces de [x] hasta las menos capaces. Si algunas son iguales, puedes ponerlas en el mismo puesto. Si algunas de ellas no tienen ningún capaz de [x], puedes ponerlas afuera.*

(i) Move: Which things are most capable of moving? *[Same across both conditions]*
Cuales de las cosas son mas capaz de moverse? [Same across both conditions]

1. Morality: Which things are more capable of telling right from wrong (or good and bad) and trying to do the right (or wrong) thing? [*Relational condition:* to others (of their kind)?]
Bueno y Malo: ¿Cuáles cosas son mas capaz de reconocer lo bueno y lo malo y de tratar de hacer lo bueno (o lo malo) [Relational condition: *a los demás (entre ellos)?]*

2. Fear: Which things are more capable of feeling afraid or fearful? [*Relational condition:* e.g., of enemies or plagues?]
Temor: ¿Cuales cosas son mas capaz de sentir temor o miedo? [Relational condition: e.g., de los enemigos, or las plagas?]

3. Memory: Which things are more capable of remembering things? [*Relational condition*: e.g., where food, water, or their home/nest is?]
Memoria: ¿Cuales cosas son mas capaz de recordar las cosas? [Relational condition: e.g., donde está su comida, agua, o su hogar/nido?]

4. Communication: Which things are more capable of expressing feelings? [*Relational condition:* to others (of their kind)?][28]

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[28] The original mind-perception survey item read "conveying thoughts or feelings to others," but this probe has two predicates that may tap different conceptions, so we chose a single predicate (presumably the more inclusive one) with "conveying feelings to others."

Comunicación: ¿Cuáles cosas son más capaz de expresar sentimientos? [Relational condition: a los demás (entre ellos)?]

5. Hunger: Which things are more capable of feeling hungry? [*Relational condition*: e.g., for food or nutrients?]
Hambre: ¿Cuales cosas son mas capaz de sentir hambre [Relational condition: e.g., por comida o nutrientes?]

6. Pain: Which things are more capable of feeling physical pain?[29] [*Relational condition*: e.g., from being hurt or sick?]
Dolor: ¿Cuáles cosa son mas capaz de sentir dolor físico [Relational condition: e.g., de ser lastimado o enfermo?]

(ii) Live: Which things have more capacity to be alive? *[Same across both conditions]*
Vivir: Cuales cosas son mas capaz de estar vivos?

B3. Participants

Don't know responses. These were treated as missing data. For inclusions, this was appropriate given that composite variables (by kind and dimension) reflect a simple mean. For the weighted rank system, however, too many missing data points led to ranks that were not strictly comparable across participants. This is because the weighted rank for each participant was calculated from the total number of items ranked, such that the lowest item (an exclusion or a last place rank) would be ranked "12" for a participant who ranked only 12 entities (leaving out two 'don't knows') but "14" for one who did rank all the entities (regardless of whether all 14 were included or not). Most Ngöbe participants (6 of 8) who gave a "don't know" response did so only once (for a single item on a single capacity ranking), so it did not appreciably affect their aggregated ranks by kind or dimension. However, two Ngöbe participants systematically gave "don't know" responses for the sun and the ocean across multiple capacities, so their aggregate rank scores did not fit the [1,14] scale and were excluded from analysis.

B4. Detailed results for preliminary analyses

Probe order. The six agency capacities were presented in one of two counterbalanced orders, the same for both cultural groups. A series of analyses on the focal outcome measures (with culture and task order as between-subjects factors) confirmed that there was no effect of probe order on agency attributions, as measured by rates of inclusion. Similarly, there was no effect of probe order on mean ranks among Ngöbe. However, probe order did affect mean ranks for US participants: the place of plants versus complex artifacts is flipped across the two probe orders, and this is reflected most strongly on the cognition dimension (there is no effect of probe order for experience). US participants were more likely to rank complex artifacts above plants on the probe order that presented Morality first, as compared to when Pain was presented first. This effect was of small enough magnitude that the overall cultural attribution profile still ranked complex artifacts well above plants on the cognition dimension (as reported in the main text).

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[29] The original mind-perception survey item read "experiencing physical or emotional pain," but this probe has two parts so we again chose a single predicate (presumably the more inclusive one) with "feeling physical pain."

B5. Detailed results for focal analyses

Overall analysis: As expected, there was a main effect of culture for inclusions, $F(1, 54) = 19.61$, $p < .001$, $\eta^2 = 0.27$, such that Ngöbe had higher rates of inclusion overall ($M = .53$, $SD = .14$) than US participants ($M = .44$, $SD = .06$). This cultural main effect was moderated by kind and (separately by) condition and dimension as described in the main text. There was no main effect of culture for ranks.

Cultural models of agency

Cultural agency attribution profiles by mean rank

Appendix Table B1. Mean ranks for agency[a] by culture

	Mean ranks[b]						
	Ngöbe (n = 22)		US (n = 35)			Overall (N = 57)	
Kind[c]	*M*	*SD*	*M*	*SD*	*U*-test	*M*	*SD*
Humans	2.90_a	(0.91)	2.87_a	(0.62)	*ns*	2.88_a	(0.73)
Animals	5.04_b	(0.98)	4.28_b	(0.39)	184.5**	4.57_b	(0.77)
Plants	8.36_c	(1.29)	9.39_c	(0.89)	172***	8.99_c	(1.17)
Abiotic kinds	9.49_d	(1.47)	11.01_d	(0.31)	72.5***	10.42_d	(1.19)
Complex artifacts	10.99_e	(0.70)	9.61_c	(1.12)	92.5***	10.14_d	(1.19)
Simple artifacts	11.63_f	(0.76)	11.13_e	(0.35)	235.5*	11.32_e	(0.60)

[a] Agency is a composite measure of memory, communication, morality, hunger, pain, and fear.
[b] Lower numbers indicate higher ranks (1 - 14); excluded items scored as tied for last.
[c] Main effect for kind: Means in the same column not sharing the same subscript differ significantly at $p < .05$ in Wilcoxon signed-rank tests.
Note: * Indicates $p < .05$; ** $p < .01$; *** $p < .001$.

Experimental Condition

Experimental Condition: Inclusions. There was a main effect of condition, $F(1, 54) = 10.08$, $p < .01$, $\eta 2 = 0.16$, with higher rates of inclusion in the relational condition ($M = .50$, $SD = .14$) as compared to the original condition ($M = .45$, $SD = .05$). But this main effect of condition was moderated by culture, such that agency attributions only varied by condition for Ngöbe participants.

Details for US inclusions by experimental condition: Original: $M = .45$, $SD = .04$; Relational: $M = .43$, $SD = .07$; condition: $F(1, 33) = 1.16$, $p = .29$, $\eta^2 = .03$; condition by kind, $F(2.22, 73.25) = 1.58$, $p = .21$, $\eta^2 = 0.05$.

Conceptual dimensions: mind-perception

Note on results reporting for conceptual dimensions by each culture: Where appropriate, degrees of freedom are adjusted using Huynh-Feldt estimates due to violation of assumption of sphericity for kind (US inclusions: $\chi^2(14) = 147.75$, $p < .001$, $\varepsilon = 0.42$) (Ngöbe inclusions: $\chi^2(14) = 78.62$, $p < .001$, $\varepsilon = 0.53$) and kind by dimension (US inclusions: $\chi^2(14) = 153.8$, $p <.001$, $\varepsilon = 0.47$) (Ngöbe inclusions: $\chi^2(14) = 51.73$, $p <.001$, $\varepsilon = 0.62$).

Cross-cultural differences on agency attribution to each non-animal kind: Mean ranks also differed in the same direction for each non-animal kind across both experience and cognition, as predicted.

Conceptual organization of agency concepts

Correlations. We also conducted a series of pairwise correlations between each of the eight individual capacities for each kind, considering each cultural group separately. These results told a roundly similar story to that of the aggregate conceptual dimensions reported in the main text.

B6. Cultural Consensus Modeling

Technically, ranking data (as opposed to normal continuous data) violates the axiom of conditional independence given that a response for one item influences the ranks available for another item. In such a case, the posterior checks can be considered approximations rather than exact indicators. However, this does not mean the model used is problematic. In fact others have used a Thurstonian model for rankings identical to the method used here (Lee et al., 2012; Lee et al., 2014), except that the CRM, which detects latent truths, extends this model to multiple cultures and also accounts for response biases and item difficulty. Additionally, the more ranks one uses (e.g., items) the less severe the violation of conditional independence; hence, we used the item-level data with 14 items rather than kind-level data with 5 kinds. As one final note, CCTpack includes two participant response bias parameters as a default setting (this measures the tendency to use the extremes as opposed to the middle of the scale). We did not include response bias parameters in our modeling simulations due to constraints from too many degrees of freedom.