

Aggressive Mimicry and the Evolution of the Human Cognitive Niche

Cody Moser¹, William Buckner², Melina Sarian, Jeffrey Winking³

¹ Department of Cognitive and Information Sciences, University of California, Merced, Merced, CA, USA

² Human Systems and Behavior Lab, Department of Anthropology, Boston University, Boston, MA, USA

³ Department of Anthropology, Texas A&M University, College Station, TX, USA

Correspondence: Cody Moser, cmoser2@ucmerced.edu

Abstract (150-250 words):

The evolution of deception is a major question in the science of human origins. Several hypotheses have been proposed for its evolution. As part of a suite of cognitive traits, these explanations are often packaged under either the Social Brain Hypothesis, which seeks to explain the current adaptive use of this suite of cognitive traits in human social contexts, and the Foraging Brain Hypothesis, which seeks to explain how external environmental drivers led to a change in the human dietary niche with a subsequent increase in foraging-specific behaviors. As these hypotheses are often presented as competing schools of thought, few lines have been proposed linking these competing explanations together. Utilizing cross-cultural data gathered from the Human Relations Area File, we identify numerous ($n = 366$) examples of the application of deception towards prey across 147 cultures. By comparing similar behaviors in non-human animals which utilize a hunting strategy known as aggressive mimicry, we suggest a potential pathway through which the evolution of deception may have taken place. Rather than deception evolving within social contexts, we suggest social applications of deception in humans could have evolved from an original context of these applications towards prey. We discuss this framework with regards to the evolution of other mental traits including language, theory of mind, and empathy.

Keywords (4-6 keywords):

Mimicry, Deception, Cognitive Evolution, Language Evolution, Hunting, HRAF

Statements and Declarations

None.

Introduction

On the level of cognition or behavior, deception is rarer in nature than honest communication (Dawkins & Krebs, 1978). Within a species, selective pressures exist for individuals to evolve deceptive behaviors, but similar selective pressures exist for individuals to detect deception or avoid the consequences of these behaviors (Wallace, 1973). Although the basis for communication lies in the use of signals by one organism to manipulate the behavior of others, counterbalancing selective forces ensure that most communication within a species is honest. Many exceptions exist to this rule and mechanisms for deception will exist in most populations, but as a general pattern, these cases are rarer than not and do not make up the majority of an animal's communicative repertoire. Despite its rarity, the extensive use of deception and the general practice of creating fiction has been noted as a hallmark of human cognition. Besides the game theoretical question of deception is a historical one which continues to puzzle biological anthropologists and evolutionary psychologists alike: given the probable paucity of deception in our primate past, why is it that humans do it so well? How is it that such cognitive features evolved in an otherwise unremarkable primate species and what were its adaptive origins?

Many proposals for the unique suite of cognitive features found in humans, including lying, rely on the idea that our mental abilities arose from a pressure to outsmart others, forming a so-called "Machiavellian Intelligence" (Whiten & Byrne, 1988a). This "Machiavellian Intelligence" refers to individuals' abilities to socially outmaneuver others to achieve a preferred outcome, often at others' expense. Packaged as part of the "Social Brain Hypothesis," a popular view is that many of our cognitive features, including our large brain sizes and our use of deception, are due to our large social group sizes and the lifestyles they impose (Barton & Dunbar, 1997). As group sizes in early humans increased, novel cognitive faculties were required by internal selection pressures to expand the relative size of the brain in order to remember other group members, to be able to recall past information, and to navigate much larger social hierarchies. What is broadly explained by this hypothesis is an account for the evolution of an understanding of mental representations shaped by conspecifics, which has been argued to be necessitated, or at least indicated, by the ability to create false beliefs (Byrne & Whiten, 1992). Yet problems with this hypothesis in its initial theoretical form exist. For example, one core tenet of the hypothesis, that brain size correlates with group size and sociality in primates and thus sociality is why our large brains and their behaviors arose, exhibits circularity on account of the fact that it fails to explain why specific group sizes are adaptive group traits on their own. Although brain size and social group size may be related, an alternative account may be that brain size *constrains* social group size rather than being evolved to facilitate them. Per the reasoning of the traditional social brain hypothesis, the reasons why our group sizes are adaptive has not been addressed.

Often taught in opposition to the social brain hypothesis is the foraging brain hypothesis proposed by Kaplan et al. (2000). Kaplan et al.'s hypothesis posits that the human brain arose as a result of large-scale climatic shifts during the Pleistocene which led to a critical change in the human dietary niche. In short, this landscape required hominins to focus on the exploitation of high-quality, not easily obtained foods not typically exploited by other animals in the landscape. In return, the brains of early *Homo* became larger and more expensive in order to take advantage of these resources. In other words, early humans shifted from a relatively easy foraging chimpanzee-like niche to a more cognitively demanding one, putting massive selective pressures on human brains and minds to exploit them. In this scenario, the expansion of the human brain is seen as the result of ecological, rather than endogenous factors such as intraspecific competition or runaway sexual selection. In this case, our behaviors became more flexible to solve more difficult to solve and variable problems in our environment with higher payoffs. Despite its strengths, it has its weaknesses compared to other models. For example, while a more expensive and larger brain seems to certainly correlate with better hunting techniques, it does not correlate with the specific cognitive adaptations that set humans apart from the rest of the primates. Why is it that quirks like theory of mind, the creation of false beliefs, and fictioneering arose with a large brain?

When studying interactions between species, the fitness benefits of deception and its adaptive origins is not an enigma. Angler fish evolved appendages to entrap their prey, predatory species of firefly mimic the lighting patterns of other species to lure them in, and carnivorous pitcher plants attract and trap insects using the enticing allure of nectar (Nelson, 2014). Among many organisms, adaptations have evolved in order to assist animals to find their food, but for many more organisms, adaptations have evolved which allow animals to bring their food to *them*. While similar selective pressures exist which would benefit prey to not be deceived by predators, the fact that predators can employ multiple strategies to multiple species of prey, that most prey items have more classes of predator than ones which employ deception, and that most forms of predator-prey deception takes the form of enhanced mimicry of a prey item's own signals (rather than withholding or altering information) makes counter-adaptations in response to a predator's adaptations more difficult for selection to act on than in intraspecific cases.

Deception in animals takes the form of at least two types: tactical deception and aggressive mimicry. In cases of tactical deception, animals either withhold or falsify information using otherwise "honest" signals from their standard repertoire to deceive other individuals (Whiten & Byrne, 1988b). Most, if not all, cases of intraspecific deception take this form. Many famous examples from outside humans come from primates, with common examples including the use of alarm calls to distract conspecifics from resources, to distract aggressors, and to hide resources or mates from other individuals (Cheney & Seyfarth, 1990). Outside of the primates, squirrels have been found to engage in deceptive caching, whereby individual squirrels create false caches containing no food in the presence of conspecifics to prevent detection of real caches (Steele et al., 2008). Corvids have similarly been found to have a direct and causal understanding of the eyesight of other corvids and use such information to hide food behind barriers (with this behavior extending even to solitary nutcrackers) (Bugnyar & Heinrich, 2005; Clary & Kelly, 2011; De Kort & Clayton, 2005; Emery & Clayton, 2004). In the cases of intraspecific communication, tactical deception is the norm.

In the other form of deception, called aggressive mimicry, individuals take advantage of the signals of their target or environmental cues in order to deceive them. Common examples in nature include angler fish evolving appendages to entrap their prey, predatory species of firefly mimicking the lighting patterns of other species to lure them in, and carnivorous pitcher plants which attract and trap insects using the enticing allure of nectar (Nelson, 2014). Such forms of bio-physical aggressive mimicry similarly stand in contrast to cognitive aggressive mimicry where deception uses behavioral, rather than physical cues, to deceive prey (Jackson & Cross, 2013).

Understanding the use of deception in the animal kingdom outside of humans may help develop a further understanding of the evolution of deception in humans. Although the lens of scientific inquiry has long been turned on the use of tactical deception in humans, few systematic attempts have been made to categorize the forms and prevalence of aggressive mimicry in human contexts. As such, this study attempts to index, categorize, and record the incidents of human aggressive mimicry in both large- and small-scaled societies using the Human Relations Area Files database, composed of ethnographic texts from 361 societies on every-human populated continent, with the addition of Oceania as a geographic region.

Cognitive Aggressive Mimicry in Animals

In order to make a direct comparison to humans, we focus on non-appendicular or non-anatomical examples of aggressive mimicry, in a form of aggressive mimicry referred to as *cognitive* aggressive mimicry (Jackson & Cross, 2013). While anatomical aggressive mimicry has evolved in a plethora of organisms from fish to snakes to mammals, a cognitive form comprised of only mimicked *behavior* is much rarer, only being consistently documented in a few species.

Among habitual mimicry in birds, two cases are consistently known in the literature and one comes from historical reporting. Among the first, field reports from multiple species of heron (family *Ardeidae*) and little egrets

(*Egretta garzetta*) show that these species employ an active form of bait-fishing in order to catch aquatic prey (Post et al., 2009). These birds, exhibiting delayed gratification, catch or otherwise acquire some form of lure, ranging from bread, feathers, plastic foam, or insects to lure more desirable prey to the edge of the water where the individual will then consume it. Although such field observations in birds are sparse, the preponderance of these observations, specifically among herons, indicate it may be an essential component of their food acquiring behavioral repertoire.

Another example from birds comes from relatively asocial shrikes (family *Laniidae*), which have been reported as far back as the medieval ages as exhibiting a form of vocal mimicry of their prey (Atkinson, 1997). Although vocal mimicry is observed as a relatively common component of avian behavioral learning, almost no examples of mimicry of *prey* items exists outside of the Laniids. The earliest recorded note regarding acoustic mimicry comes from the nun Juliana Berners, author of the *Book of Saint Albans*, who noted in 1486, “She will stand at perch upon some tree or poste, and there make an exceedingly lamentable crye and exclamation.. All to make other fowles to thinke that she is very much distressed and stands in need of ayde; whereupon the credulous sellie birds do flocke together at her call. If any happen to approach near her, she... ceazeth on them, and devoureth them (ungrateful subtil fowle) in requital for their simplicity.” Field experiments by Atkinson (1997) indicate that non-European northern shrikes (*Lanius excubitor*) utilize acoustic mimicry to imitate the alarm calls of small passerine birds in winter to lure them towards hidden perches. These behaviors among the shrikes contrast in relation to the relatively small body size of shrikes compared to other carnivorous birds, and may give them a comparative advantage when compared to much larger predatory birds such as raptors. It is similarly worth noting that while asocial, shrikes share a recent common ancestor with the *Corvidae*, a family long characterized for its comparative intelligence (Jönsson et al., 2016). Relatedly, two species of corvid, blue jays (*Cyanocitta cristata*) and Steller’s jays (*Cyanocitta stelleri*), have been noted to employ a defensive form of aggressive mimicry while mimicking the calls of their own avian predators (Hailman 2009; Tippin, 2017).

Finally, in the most phylogenetically unique example of mimicry, spiders of the genus *Portia* utilize deception to acquire and consume much larger, more venomous prey, especially wolf spiders (Jackson & Blest, 1982). Deception in these instances often takes the form of faking vibrational signals on prey items’ webs, taking advantage of a signal used by wolf spiders used to detect the presence of prey, potential mates, and rival conspecifics. Altering its strategy based on trial-and-error learning and fossilizing these behaviors based on the type of prey *Portia* encounters, these spiders invade the webs of other spiders and mimic the vibratory signals of trapped prey or the signals of potential mates in order to draw prey spiders toward them. Such cases have been documented in a wide array of other spiders including, the jumping spider genres of *Brettus*, *Cyrtus*, and *Gelotia* and in the pirate spiders of the family *Mimetidae*. Similar examples have been found outside of spiders in spider-eating assassin bugs (Wignall & Taylor, 2011).

Aside from these habitual examples, other examples exist in the literature where animals have been shown to display some form of cognitive aggressive mimicry, although these behaviors have not been generalized in studies of these animals. For example, multiple Central and South American big cats (*Puma concolor*, *Panthera onca* and *Leopardus pardalis*) have been reported by Amazonian inhabitants to mimic the vocalizations of primate prey such as the pied tamarin (*Saguinus bicolor*), a claim which has been further supported by field observation (de Oliveira Calleia et al., 2009). Two crocodilian species (*Crocodylus palustris* and *Alligator mississippiensis*) have also been observed using twigs and sticks for camouflage and as hunting lures, primarily during the nest-building season of their prey (Dinets et al., 2015).

Cognitive Aggressive Mimicry in Humans

The use of deception in hunting practices has been well documented as a common practice by contemporary hunters. As rare as aggressive mimicry is in the animal kingdom, anecdotally it appears to be

relatively common in humans. Hunters in the Southeastern United States regularly utilized “hawk whistles” while hunting rabbits and squirrels as follows (Angier & Young, 2016): hunters who startled (and startle, as the strategy is still in use) their prey could momentarily halt the prey’s fleeing behavior by releasing a high-pitched whistle thought to mimic the sound of the hawk. Archaeological evidence of the use of decoys in hunting contexts dates back in the Western Hemisphere at least 2,000 years (Hitchcock et al., 2019), and in Micronesia for at least 3,000 years (Carson & Hung, 2021). The explicit copying of avian vocalizations by human hunters and speakers even possesses its own term: warblish (Sarvasy, 2016), defined as: “The phenomenon of vocal imitation of avian vocalizations by humans, using existing non-onomatopoeic word(s), as with English *who cooks for you?* (for the Barred owl call) and *Chicago!* (for the California quail call); or a particular vocal imitation using existing word(s).”

Two questions arise from anecdotal recordings of this behavior: first, is it universal; second, is it effective? This study therefore seeks to partially address the first question and the implications of the universality of human deception towards prey species.

Methods

We utilized the online Human Relations Area Files database to compare occurrences of aggressive mimicry across human societies with differing locations and subsistence strategies. The sample itself is composed of ethnographic texts from 326 societies on every human-populated continent on the planet at the time of this search, with the addition of Oceania as a geographic region. Societies are split both by regions within these continents and subsistence type (e.g., hunter-gatherer, pastoralist, industrial diaspora). As a large database composed of thousands of ethnographic texts, the Human Relations Area Files’ online component (eHRAF) lends itself to text-scraping methods as querying terms which are pertinent to searches will extract the pertinent information surrounding them.

Utilizing the Human Relations Area Files, we proceeded to identify the use of aggressive mimicry with the root of the following terms: deceive, deception, decoy, imitate, lure, and mimic. More specifically, with eHRAF’s system for querying searches, we used the items *deceiv**, *deception*, *decoy**, *imitat**, *lure**, *luring*, and *mimic**. eHRAF additionally allows the filtering of search terms by subject. Subjects were limited to: Agriculture, Animal Husbandry, Food Consumption, Food Quests, and Ideas about nature and people. In order to comprehensively assess the context of each category of deception, we collected data on types of prey captured/killed: fishing, large mammal (and type of mammal), small mammal, carnivore (and type of carnivore), birds, and primates. The social context of the lure was also ascertained based on the surrounding text: individual, group, or unknown.

In addition to these, the sensory system which was exploited by humans in each context included: acoustic lures, baiting, fire fishing, olfactory, visual, a mix of any types, and ambiguous. These were determined based directly on the manner by which the lure was communicated to prey. Because many of the samples from fishing contexts consist primarily of baiting, we analyze the dataset both with and without fishing included.

Acoustic mimicry is typically accomplished vocally, although in some societies this is achieved with the use of an instrument, such as among the Assiniboiné of North America, who use whistles made of wood to lure deer and elk (Denig & Hewit, 1930). These examples are not limited to just terrestrial prey, either. One acoustic lure for fish among the South American Ticuna is described as follows, “With the ball he strikes the surface of the water, thus imitating the fall of fruits, in order to attract certain fish—especially tambaquis (*Colossoma bidens*) and pacú (*Myteles sp.*) (Nimuendajú, 1952).”

Visual mimicry commonly involves the use of special clothing, items, or movements to decoy the animal. For example, among the Chukchi of Siberia, a hunter wears a sealskin hat imitating a seal’s head, wields a special scraper with seal’s claws attached, and moves imitating the movements of the seal, periodically scratching the ice with the claws, until he is close enough to strike with a harpoon throw (Antropova & Kuznetsova, 1964).

Vibrational cues are those which use natural vibrations in the ground, in trees, or otherwise in the environment to attract prey. An example of a vibrational cue comes from the Kimam Papuans who used vibrations for kangaroos by, “[taking] advantage of the natural curiosity of kangaroos by stamping on the ground from time to time while approaching their game, in imitation of a jumping kangaroo. (Serpenti, 1965)”

Baiting cues were cues in which some form of generalized bait was provided to animals, such as food or a potential competitor. For example, one form of baiting using either food or tobacco leaves was described among the Iroquois, “There is a close relationship between the old Seneca custom of sacrificing the first-killed deer to the meat-eating birds of prey and the widespread American Indian technique of luring down birds to shoot them or take them by pit trapping. (Fenton, 1953)” Relatedly, mates or potential competitors may be used, as among the Eastern Toraja of Southeast Asia, “First the Toradja sees to it that he has tamed a female buffalo which is to help him with the catching; such a decoy animal is called poanda. People set out during the day and also often at night by moonlight. The buffalo cow is held on a line fastened to the nose ring. (Adriani & Kruijt, 1951)”

Fishing cues were generally either some form of line fishing, in which bait is placed on a hook or tied to a line, and sent out into the water. Where the bait is explicitly mentioned, these examples are coded as “baiting,” but where it is unspecified, we code it as fishing. As much of the dataset specifically with regards to baiting is skewed by the presence of fishing examples, we analyze the results both with the inclusion of these examples and their exclusion. One special form of, presumably, visual mimicry was that of the use of fire to lure fish, and is also coded separately. As noted among the Micronesian Yapese people, “The period for catching flying fish, in May and June, represents a week-long festival, during which all the able-bodied men go out to sea night after night in whole flotillas of canoes, lure the schools from the water by torchlight, and snatch the dazzled sea-inhabitants by the thousands out of the air with long-handled hoop-net, like butterflies. (Müller, 1917)” This form of mimicry or visual baiting was coded separately.

A mixed form of exploitation involved any two or more of the other types of contexts, often in the form of decoys. For example, among the Asian Eastern Toraja, “Here he limitates [sic] the sounds of wood pigeons (lebago, togooe), in order to lure these birds. For this purpose he also has with him a decoy pigeon on a perch with a long pole. (Adriani & Kruijt, 1951)” Textual descriptions for most of the examples in eHRAF can be found in Supplementary Table 1.

Finally, the directedness of the lure, defined as luring the animal directly using a signal from the body, were also ascertained as: direct (using the body), indirect (using another organism, as in the case of baiting, or tool), or ambiguous. For example, one description of the Amazonian Sirionó was coded as both a direct and indirect acoustic lure for alligators, “Newborn alligators are sometimes used by hunters to attract the mother. When a young alligator is caught it begins to cry for its mother, who, upon hearing it, comes running out of the water to retrieve it. The hunter, waiting on shore, strikes the mother over the head with a club as she comes up the bank. By imitating a young alligator a hunter can often produce the same result (Holmberg, 1950).”

Results

The results of the eHRAF term search can be found in the Appendix and are summarized here. The six terms Deceiv*, Deception, Decoy*, Imitat*, Lure*/Luring, and Mimic* yielded 324, 111, 327, 1365, 603, and 131 paragraphs, respectively. Of these Deceiv* yielded 18 results of aggressive mimicry, Deception yielded 5, Decoy* yielded 109, Imitat* yielded 80, Lure*/Luring yielded 146, and Mimic* yielded 8 for a total of 366 examples pulled from eHRAF. Of these, nine examples were pulled not because they contained aggressive mimicry, but were specific references to cultural practices surrounding it – of these, three (Andaman Islanders, Plains Omaha, and Amazonian Tukanos) had references to the practice without referencing employing it or were ambiguous about its

use. From the total 366 ethnographic examples, 147 cultures from 34 regions in all 7 continent groups had some form of aggressive mimicry. This represents roughly 46% of eHRAF's cultural dataset.

The median number of forms of aggressive mimicry practiced by groups was two, with a range between one (n=59, 40% of the sample) and ten (n=1, < 1% of the total sample, among the Subarctic Ojibwa). That said, many texts contained references to the use of aggressive mimicry tactics employed against multiple animals but were only recorded once. For example, for the Yanomama of the Amazon and Orinoco Basin, the excerpt (Becher & Schütze, 1960) reads as follows, "They discover every trial [sic] of a wild animal, no matter how faint, sniff it, and announce the time when it was at this place. Often they then follow it for hours through the almost impenetrable forest; sometimes they are gone for several days. Moreover, they know how to attract the animals by imitative sounds." As the ethnographer only reported this tactic as being employed against "animals," only one instance could be recorded.

Because these data are mostly intended to demarcate presence/absence and very few (n = 2, <1% of the total sample) mention an absence of the pattern, it is likely that the data here are an undersampling of the use of aggressive mimicry in traditional societies. For one example, among the Amazonian Tukanos, the use of mimicry is noted, but the ambiguousness of the excerpt did not allow us to record this group as using the mimicry for luring, "there they patiently stay in ambush without making any noise, or imitating the chirping of the birds that they want to kill...When they hunt with a companion, imitations of bird calls are used for communication (Jackson, 1983)." The ethnographer may have intended to say that the hunters sit in silence or that while waiting for birds, they imitate bird calls, but the ambiguity of the sentence and lack of context clues did not allow us to determine whether a call was being used, either.

Table 1: Sensory Exploitations for All Forms of Mimicry

Exploitation	Number	Percent
Acoustic	133	36.3%
Visual	115	31.4%
Bait	45	12.3%
Fishing	21	5.7%
Mixed	21	5.7%
Fire Fishing	9	2.4%
N/A	9	2.4%
Olfactory	7	1.9%
Vibration	3	0.8%
?	3	0.8%

All forms of sensory exploitation for each culture across all prey types

With regards to the modes of sensory exploitation, results are reported in Table 1. A total 36% (n = 133) of all mimicry was acoustic, 31% (n = 115) was visual, 12% (n = 45) was baiting, 6% (n = 21) was fishing (whereby

the sensory mode being exploited was ambiguous but directed towards fish), 6% (n = 21) was mixed (largely a mixture of visual/acoustic or visual/olfactory), 2% (n = 9) was fire fishing (employing fire to lure fish to the surface of the water), 2% (n = 9) was olfactory, 1% were ambiguous (n = 3) , and 1% (n = 3) involved ground vibrations (limited to cases involving the luring of kangaroos or termites). As many (but not all) forms of fishing involve the same type of general baiting method, the percentages reported with fishing removed from a modified sample (n = 292 out of 366) are reported in Table 2.

Table 2: Sensory Exploitation for Non-Fishing Forms of Mimicry

Exploitation	Number	Percent
Acoustic	124	42.5%
Visual	87	29.8%
Bait	40	13.7%
Mixed	20	6.8%
N/A	9	3.08%
Olfactory	7	2.4%
Vibration	3	1.0%
?	2	0.7%

All forms of sensory exploitation for each culture across prey types with fish removed.

It is worth noting that while all fishing examples have been removed from the subsample described above, not all or even a grand majority of forms of fish exploitation involved direct line baiting. Compelling examples include the use of shark rattles among the Melanesian Trobrianders and Santa Cruz Islanders, as well as Polynesian Samoans; the construction of rat dummies amongst Samoans the Polynesian Tongans; the luring of fish through the trapping of conspecifics by Tongans, Samoans, and North American Northern Paiutes; and the use of other acoustic signals by East African Nuer, Micronesian Woleains, Polynesian Samoans and Lau Fijians, and Amazonian Ticuna). Among these non-line baiting forms of sensory exploitation toward fish, we collected 53 samples. 52% of these samples (n = 28) were visual, 17% (n = 9) were acoustic, 17% (n = 9) were fire fishing, 9% were baiting (n = 5), 2% (n = 1) were ambiguous, and 2% (n = 1) were mixed. “Baiting” refers to the use of a fish’s conspecifics and “Fire Fishing” refers to the use of torches for luring fish towards the top of water at night.

Besides geographic continent and region, the eHRAF database breaks down each culture by its subsistence type. In this search, eight subsistence types were identified comprising different proportions of the sample: Agro-Pastoralists (3%, n = 11), Commercial Economy (<1%, n = 1), Horticulturalists (17%, n = 64), Hunter-Gatherers (43%, n = 158), Intensive Agriculturalists (7%, n = 26), Other Subsistence Combinations (16%, n = 59), Pastoralists (5%, n = 17), and Primarily Hunter-Gatherers (8%, n = 30). For the purpose of simplifying analysis, we broke the categories down into three groups loosely based on the sociopolitical typology of complexity described by Service (1963) ranging from foraging societies to horticultural societies to pastoral societies (chiefdoms) to agriculture. As the foraging systems of pastoralists and agriculturalists are not too dissimilar in terms of scale, we further collapsed these last two categories into one; we keep the distinction between horticulturalists and this group as they represent an in-between state between a primary reliance on foraged foods and a primary reliance on agricultural products. This classification yielded the following three groups: hunter-gatherers (51%, n = 188), horticulturalists (17%, n =

64), and other subsistence types (31%, n = 114). A breakdown of sensory exploitations for each of these groups can be found in Table 3.

Table 3: Sensory Exploitation by Subsistence Type

Subsistence Type	Exploitation	Number	Percent
Hunter-Gatherers	Visual	68	36.2%
	Acoustic	65	34.6%
	Bait	24	12.8%
	Mixed	10	5.3%
	Fishing	7	3.7%
	N/A	5	2.7%
	Olfactory	5	2.7%
	?	2	1.1%
	Fire Fishing	2	1.1%
			100%
Horticulturalists	Acoustic	35	54.7%
	Visual	10	15.6%
	Bait	5	7.8%
	Mixed	5	7.8%
	Fishing	4	6.3%
	N/A	3	4.7%
	Vibration	2	3.1%
			100%
Other Subsistence Combinations	Visual	37	32.5%
	Acoustic	33	29.0%
	Bait	16	14.0%
	Fishing	10	8.8%
	Fire Fishing	7	6.1%
	Mixed	6	5.3%

	Olfactory	2	1.8%
	?	1	0.9%
	N/A	1	0.9%
	Vibration	1	0.9%
			100%

A breakdown of each sensory exploitation by society subsistence type: hunter-gatherer, horticulturalist, and other subsistence types.

Of the 51% of the total samples we obtained from our eHRAF search which are categorized as hunter-gatherers, the sample consists of exclusive hunter-gatherers (58 cultures) and *primarily* hunter-gatherers (26 cultures). Of the 58 hunter-gatherers, 57 (98%) had some form of aggressive mimicry. Of the 26 primarily hunter-gatherers, 15 (58%) had aggressive mimicry. For horticulturalists the number is roughly half (51%, 27/53), and following that, the numbers drop off drastically with 23% (23/100) of the remaining societies having examples of aggressive mimicry.

Finally, the directionality of each incident of aggressive mimicry was recorded for this study, yielding the following values: direct, indirect, fishing, and ambiguous. The results of these are in Table 4. Direct refers to a hunter luring an animal directly to his/her self, rather than towards an external object, scent, sound, or decoy (denoted as indirect). The overall results are as follows: 52% (n = 191) direct, 42% (n = 152) indirect, 3% (n = 10) which did not specify, 3% (n = 9) fishing, and 1% (n = 4) ambiguous.

Table 4: Directionality of Mimicry for All Forms of Mimicry

Directionality	Number	Percent
Direct	191	52.2%
Indirect	161	43.9%
N/A	10	2.7%
?	4	1.1%

Directionality of each form of mimicry including direct (self-referential), indirect, unspecified, and uncertain directions.

Discussion

The reviews of the animal literature and ethnographic record suggest that while cognitive aggressive mimicry is rare among animals, it is ubiquitous among human hunters. An exploration of the role of aggressive mimicry in the human niche might inform longstanding debates regarding our cognitive evolution and even more general discussions of ethics. While there is fair agreement that the human mind is shaped through its interaction with the minds of other individuals, be it through evolutionary, developmental, or cultural processes, much less is known about how the mind is and has been shaped by the minds of non-human agents.

Following our discussion of the Social Brain Hypothesis and the Foraging Brain Hypothesis, we believe that the use of deception in hunting contexts could provide one link between the two causal stories separately presented by each hypothesis. While the Social Brain Hypothesis explains the intraspecific adaptive value of each of our cognitive traits, the Foraging Brain Hypothesis explains many of these traits in terms of external environmental problems that early humans had to solve. By linking the use of these intraspecific traits to interactions with prey in order to acquire food, these hypotheses may find consilience. A possible pathway for these traits therefore follows.

As the Pleistocene environment began fluctuating, humans were driven into a novel dietary niche which was characterized by both dietary plasticity and an emphasis on hard-to-obtain foods that other animals (such as competing baboons) were not focused on. Following this came adaptations for behavioral plasticity which necessitate 1) more expensive brains and 2) longer lifespans to afford such expenses, as in the Foraging Brain Hypothesis (Kaplan et al., 2000). From the expensive brain came more plastic behaviors including copying the successful behaviors of others (Muthukrishna et al., 2018) and deception of prey. These traits were then employed in a more social setting leading to classic forms of Machiavellian deception and language that we find associated with the Social Brain Hypothesis (Barton & Dunbar, 1997). Several of these traits, including theory of mind and deception, language, and empathy are discussed further below.

The Evolution of Human Deception

In the ethnographic accounts of aggressive mimicry, two interrelated concepts are at play for human-animal relationships: theory of mind and the use of theory of mind for deception. Theory of mind, or the recognition that other animals have mental states themselves and the prediction of their behavior based on these mental states, is often invoked in accounts of Machiavellian intelligence whereby theory of mind and other elements of human intelligence arose through an evolutionary arms race of social cognition. As group sizes increased and more complex patterns of group behavior, such as food sharing, emerged, those who were better at manipulating and deceiving might have secured larger portions of the collective pie (Dunbar, 1998; Whiten & Byrne, 1988a). However, directional selection for deceptive abilities would likely be muted by counter-selective pressures: deception towards conspecifics is rare in nature, including in primates, largely for the reason that communication systems can only be maintained if the signals are predominantly useful to the receiver, i.e. honest. From a game theoretical perspective, as deceptive signals become more common, receivers would become less attuned to them, and the benefits to transmitting them would decrease in tandem. Hence most communication between *conspecifics* is cooperative and honest (Wallace, 1973; Dawkins & Krebs, 1978).

But external to our interaction with human minds are the minds of those we do not necessarily cooperate with: the minds of our prey. While it is undoubtedly true that humans lie to each other, and do so extensively, in our early evolutionary history prior to complex communication and vast semiotic complexes, our use of deception may have been primarily geared towards non-conspecifics (Barrett, 1999). These early versions of deception towards prey may have scaffolded further elaboration for deception against other humans. For example, patterns observed among 10 hunter-gatherer societies in the Probability Sample Files within HRAF have similarly noted that most hunter-gatherer disguises are used specifically in the context of visual deception towards prey, with fewer versions of camouflage being used towards humans for war (Buckner, 2021). The use of such deception and our application of theory of mind towards other animals may have guided further forms of deception and fictioneering in general, such as in cases of shamanism where shamans envision themselves in the worlds of others or early animistic religions where intentionality in nature is not limited only to humans, but extends to non-human animals and inanimate objects (Willerslev, 2007).

From a paleoanthropological standpoint, this cognitive suite of human mental capacities likely arose at the same time that early humans underwent their shift into a unique dietary niche, switching from lower nutrient, easier-to-obtain foods such as common plants and fruits, to higher nutrient, and more difficult-to-obtain foods such as

underground storage organs and meat from other animals (Kaplan et al., 2000). It was during this time that humans began to explore the carnivorous niche and entered the predator guild, and with the increased consumption of fats and proteins, the human brain was able to evolve larger and develop behavioral strategies to continue to feed itself (Bunn & Gurto, 2014). With these behavioral strategies came the suite of cognitive traits which we have come to define the human mental niche (Kaplan et al., 2000; Muthukrishna et al., 2018).

Recent evidence points to the idea that our earliest ancestors at early hominin kill sites were ambush predators (Bunn & Gurto, 2014). The use of aggressive mimicry in these contexts to lure prey may have therefore scaffolded further brain evolution and the movement of the genus *Homo* into a carnivore niche and similarly scaffolded the use of these mental traits in non-hunting contexts. Take for example, theory of mind. Several examples from the literature compiled here evidenced an understanding of animals' mindsets when deceiving them. The Semai of Southeast Asia, for example, refused to use the proper names of animals they were hunting while hunting them under the guise that most animals know their true name. As noted by Dentan (1968), "The east Semai do not use the real 'name' of an animal they are hunting or eating... Instead of defying something that threatens them, the Semai try to deceive it." Similarly among the Mbuti (pygmy) foragers of West Africa, Turnbull (1965) noted that many magical rituals invoking animal spirits were, "believed to convey to the hunter the senses of the animal so that he will be able to deceive the animal as well as foresee his movements."

The Evolution of Vocal Plasticity

One of the few aspects that separate human language ability from primate vocal abilities is its flexibility and plasticity. As noted by Cheney and Seyfarth (2005), primate brains are almost primed for language perception. That is, limited numbers of signals can be perceived and employed in an almost limitless number of contexts. This is not unique to primates, either, as noted by Cheney and Seyfarth, who state, "while the number of distinct calls that animals produce is highly constrained, the number of signs that a parrot, dolphin, sea lion, or chimpanzee can learn to associate with a given stimulus or outcome is, if not limitless, certainly in the tens to hundreds." As shown in the ape language experiments, the issue with human language is not at all in its perception, but in its production (Cheney & Seyfarth, 1998; Fitch, 2011).

For comparative biology, the central question as noted by Seyfarth and Cheney (2010) is, "Why should an individual who can deduce an almost limitless number of meanings from the calls of others be able to produce only a limited number of calls of his or her own?" Their answer is that Theory of Mind came first and plasticity came later. Yet such an answer does not give any indication as to what the proto-steps towards plasticity may have looked like or why sociality and Theory of Mind would be so important. Instead, they argue that nonhuman primates can think in simple sentences but are simply not motivated to because they cannot place themselves in their conspecifics' minds. The fact is that natural selection deemed what calls they possess as good enough- there was never a substrate for which natural selection to build vocal plasticity upon because primates never needed it.

What would such a proto-step towards plasticity look like? For humans, the use of vocal aggressive mimicry is one potential substrate (Knight & Lewis, 2017). For all regions save for Europe and North America, acoustic exploitations were the primary form of aggressive mimicry, and among acoustic mimicry, 85.6% of it was as a direct (self-emitted) imitation of prey or predators of prey. Not only does aggressive mimicry provide a causal ecological driver for the evolution of vocal plasticity, it also at least partially gives a causal driver for theory of mind. As noted in our sample by Schultze (1907) while working among the Khoi, "Here it is especially clear how the choice of the words, their sequence and accentuation, aim at an imitation of the animal voice. It seems to me that certain observations from the primitive stages of an incipient literature (such as the Hottentots represent) are not without value in determining how man originally came to give his speeches certain rhythms when he wants to free them from oppressive monotony and use them for freer creations of the phantasy. It is no hypothesis but an ascertainment of the actual state of affairs that, in the Nama language, the childish joy in imitating certain animal

voices with words represents one way to rhythmical development.” Such an idea was perhaps first elaborated by Lucretius in his sole surviving work, *De rerum natura*, written in the middle of the 1st century, BC, “Men learnt to mimic with their mouths the trilling notes of birds long before they were able to enchant the ear by joining together in tuneful song.”

This hypothesis finds support in recent developments in phonetic theory. Perception-for-Action-Control Theory (PACT) posits, based on neurological and phonetic evidence showing that humans actively turn heard phonetic sounds into motor action through our pre-motor circuitry, that our acoustic systems were adapted for pre-linguistic functions involving mimicry (Schwartz et al., 2012; Schwartz et al., 2007). As Schwartz et al. (2007) argues, “PACT assumes that speech perception not only allows listeners to follow the vocalizations...in order to understand them, but also to imitate and learn.” While non-human primates can *technically* produce the same range of phonetic sounds that humans can, the strengthening of neuro-motor connections between our perceptual systems and our vocal apparatus would have given us, and currently provides modern hunters, with the breadth to mimic virtually any prey item through the copying of complex calls, trills, and whistles, and may have scaffolded the further development of language with its own vast but seemingly arbitrary phonetic breadth.

The Evolution of Empathy

Why do people love animals but also want to eat them? Such a question remains an enigma in psychology where it has been given the appropriate name, “The Meat Paradox” (Loughnan et al., 2010). In the extensive ethnographic reports gathered from eHRAF, in addition to simply applying theory of mind towards hunters, a number of records explicitly note regret and sympathy by the hunters themselves towards their prey. As stated by one informant among the Semai of the Malay Peninsula, “You have to deceive and trap your food, but you know that it is a bad thing to do, and you don’t want to do it. Being forced to what you do not want to do is spiritually harmful. (Dentan, 2008)”

Despite the lethality involved, hunters often express a desire to not offend, or show special respect and courtesy towards, their prey. Among both the Guayaki of the Amazon, and the Batek of Malaysia, the common names of animals are often not used in association with the hunt, as this is considered disrespectful to the animal. Offerings of food or drink, special methods of treating and disposing of the carcass, and other rituals of honor that impose some cost on the hunter are commonly found across many hunting societies. There is an oft reported notion that the materials and sustenance provided by the prey animal must be paid back by the hunter, through particular demonstrations of appreciation, to appease the animal spirits and propitiate their continued presence in the world (Halfon & Barkai, 2020).

While such a pattern does constitute a paradox, the evolutionary link between both empathy and theory of mind has previously been considered, at least from an intraspecific approach (Seyfarth & Cheney, 2013). Consider instead the case where theory-of-mind is applied towards animals in order to better understand or predict their behavior (just as it is applied towards others humans): the recognition that an animal or other organism shares a mind like one’s own immediately opens lines of empathy from human to animal (Shepard, 1998; Willerslev, 2004). Paradoxically, indeed, our ability to recognize the mental worlds of our prey allows us to better predict their behavior in the future while tragically placing us to understand, or even inaccurately project, their own feelings regarding their capture and demise.

Conclusion

In conclusion, cognitive aggressive mimicry appears to be rare in nature, but ubiquitous in humans. Hunters around the world, in subsistence-level societies and large developed countries who pursue game for sport, employ a range of deceptive practices and mimicry towards their prey in order to acquire protein in their lives. This deception

takes the form of directly copying the calls of animals with our own vocal apparatus, luring animals in with their hurt conspecifics, baiting them with potential mates or competitors, and creating completely false decoys which faithfully deceive their prey. Whether this arose early or late in our evolutionary trajectory is uncertain, but the use of it in virtually every hunter-gatherer society in the Human Relations Area Files database may indicate that it has been used for quite some time and would have yielded serious fitness benefits for early humans which were able to draw their prey in.

While such a pattern is extensively found around the world, the evolutionary and cognitive implications of this pattern are varied. Further research specifically on theory-of-mind, vocal mimicry of prey, and empathy towards prey may help elucidate what role this practice may have played in our evolutionary history, as this preliminary search indicates that the presence of aggressive mimicry early in our evolutionary past may partially explain several longstanding questions in these areas.

Finally, we hope that the role that non-human minds play in shaping human minds is taken more seriously in future evolutionary research and recognize that mimicry and deception are not the full extent to which animal-human interactions may have played a role in developing our psyche. Take for example the mutualistic interaction between honeyguides and the Hadza in East Africa where Hadza foragers develop whistles with which to call small birds which then bring them to honey; both hunters and birds benefit through this interaction when humans obtain and share these resources with their guides (Wood et al., 2014). Similar lines of research may ask what a human and non-human interaction lacking theory of mind might potentially look like, as with cross-cultural development in children or with unique cases such the case of Temple Grandin, a researcher with autism and lacking theory of mind, and the extensive role she has played in promoting animal welfare around the world (Grandin, 1992).

Data Availability

All data generated or analysed during this study are included in the Zenodo repository, <https://doi.org/10.5281/zenodo.6979028>.

Authorship Contributions

Study conception and design were performed by Cody Moser. Framing and extensive edits on the manuscript were performed by Jeffrey Winking. Material preparation, data collection and analysis were performed by Cody Moser. Data were checked and re-verified by William Buckner and Melina Sarian. The first draft of the manuscript was written by Cody Moser and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

Not applicable.

References

- Adriani, Nicolaus, and Albertus Christiaan Kruijt. (1951). *Bare'E-Speaking Toradja Of Central Celebes (The East Toradja): Third Volume*. Verhandelingen. Amsterdam: Noord-Hollandsche Uitgevers Maatschappij.
- Antropova, V. V., and V. G. Kuznetsova. (1964). "Chukchi." *Peoples Of Siberia*. Chicago And London: University of Chicago Press.
- Atkinson EC. (1997). Singing for Your Supper: Acoustical Luring of Avian Prey by Northern Shrikes. *The Condor*, 99(1):203-206.

- Barrett HC. (1999). *Human cognitive adaptations to predators and prey*: University of California, Santa Barbara.
- Barton, R. A., & Dunbar, R. I. (1997). Evolution of the social brain. In A. Whiten, & R. W. Byrne (Eds.), *Machiavellian intelligence II: Extensions and evaluations*.
- Becher, Hans, and Frieda Schütze. (1960). *Surara And Pakidai, Two Yanoama Tribes In Northwest Brazil*. Mitteilungen. Hamburg: Kommissionsverlag Cram, De Gruyter & Co.
- Buckner, W. (2021). Disguises and the Origins of Clothing. *Human Nature*, 32(4), 706-728.
- Bugnyar T, and Heinrich B. (2005). Ravens, *Corvus corax*, differentiate between knowledgeable and ignorant competitors. *Proceedings of the Royal Society B: Biological Sciences*, 272(1573), 1641-1646.
- Bunn HT, and Gurtov AN. (2014). Prey mortality profiles indicate that Early Pleistocene Homo at Olduvai was an ambush predator. *Quaternary International*, 322, 44-53.
- Carson, M. T., & Hung, H. C. (2021). Let's catch octopus for dinner: ancient inventions of octopus lures in the Mariana Islands of the remote tropical pacific. *World Archaeology*, 53(4), 599-614.
- Cheney DL, and Seyfarth RM. (1990). *How monkeys see the world: Inside the mind of another species*. University of Chicago Press.
- Cheney DL, and Seyfarth RM. (1998). Why animals don't have language. *Tanner Lectures on Human Values*, 19, 173-210.
- Clary D, and Kelly DM. (2011). Cache protection strategies of a non-social food-caching corvid, Clark's nutcracker (*Nucifragacolumbiana*). *Animal Cognition*, 14(5), 735-744.
- Dawkins R, and Krebs JR. (1978). Animal signals: information or manipulation. In J.R. Krebs, & N. B. Davies (Eds.), *Behavioural ecology: An Evolutionary Approach*, (pp. 282-309). John Wiley & Sons.
- De Kort SR, and Clayton NS. (2005). An evolutionary perspective on caching by corvids. *Proceedings of the Royal Society B: Biological Sciences*, 273(1585), 417-423.
- de Oliveira Calleia F, Rohe F, and Gordo M. (2009). Hunting strategy of the margay (*Leopardus wiedii*) to attract the wild pied tamarin (*Saguinus bicolor*). *Neotropical Primates*, 16(1), 32-34.
- Denig, E. T., and Hewitt, J.N.B. (1930). *Indian tribes of the Upper Missouri*. Anboco.
- Dentan, Robert Knox. (1968). "Semai: A Nonviolent People Of Malaya." In G. Spindler, & L. Spindler (Eds.), *Case Studies In Cultural Anthropology*. New York: Holt, Rinehart and Winston.
- Dentan, Robert Knox. (2008). "Overwhelming Terror: Love, Fear, Peace, And Violence Among Semai Of Malaysia." Lanham, Md.: Rowman & Littlefield Publishers.
- Dinets V, Brueggen J, and Brueggen J. (2015). Crocodilians use tools for hunting. *Ethology Ecology & Evolution*, 27(1), 74-78.
- Dunbar RI. (1998). The social brain hypothesis. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews*, 6(5), 178-190.

- Emery NJ, and Clayton NS. (2004). The mentality of crows: convergent evolution of intelligence in corvids and apes. *Science*, 306(5703), 1903-1907.
- Fenton, W. N. (1953). *The Iroquois Eagle Dance: An Offshoot of the Calumet Dance*. Syracuse University Press.
- Fitch WT. (2011). Speech perception: A language-trained chimpanzee weighs in. *Current Biology*, 21(14), R543-R546.
- Grandin T. (1992). Calming effects of deep touch pressure in patients with autistic disorder, college students, and animals. *Journal of Child and Adolescent Psychopharmacology*, 2(1), 63-72.
- Hailman, J. P. (2009). Context of blue jay (*Cyanocitta cristata*) mimicking Cooper's Hawk (*Accipiter cooperii*) cackle. *Florida Field Naturalist*, 37(3), 94-94.
- Halfon E, and Barkai R. (2020). The material and mental effects of animal disappearance on indigenous hunter-gatherers, past and present. *Time and Mind*, 13(1), 5-33.
- Holmberg, Allan R. (1950). *Nomads Of The Long Bow: The Siriono Of Eastern Bolivia*. Smithsonian Institution. Institute Of Social Anthropology. Washington: U.S. Govt.
- Jackson, J. E., & Jackson, J. E. (1983). *The fish people: Linguistic exogamy and Tukanoan identity in Northwest Amazonia* (No. 39). Cambridge University Press.
- Jackson R, and Blest A. (1982). The biology of *Portia fimbriata*, a web-building jumping spider (Araneae, Salticidae) from Queensland: utilization of webs and predatory versatility. *Journal of Zoology*, 196(2), 255-293.
- Jackson RR, and Cross FR. (2013). A Cognitive Perspective on Aggressive Mimicry. *Journal of Zoology*, 290(3), 161-171.
- Jønsson KA, Fabre P-H, Kennedy JD, Holt BG, Borregaard MK, Rahbek C, and Fjeldså J. (2016). A supermatrix phylogeny of corvid passerine birds (Aves: Corvides). *Molecular Phylogenetics and Evolution*, 94, 87-94.
- Kaplan H, Hill K, Lancaster J, and Hurtado AM. (2000). A theory of human life history evolution: diet, intelligence, and longevity. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews*, 9(4), 156-185.
- Knight C, and Lewis J. (2017). Wild voices: Mimicry, reversal, metaphor, and the emergence of language. *Current Anthropology*, 58(4).
- Loughnan S, Haslam N, and Bastian B. (2010). The role of meat consumption in the denial of moral status and mind to meat animals. *Appetite*, 55(1), 156-159.
- Müller, W. (1917). Yap 1: Halbband in Ergebnisse der Südsee Expedition (1908–1910). Hamburg: Herausgegeben von G Thilenius.
- Muthukrishna M, Doebeli M, Chudek M, and Henrich J. (2018). The Cultural Brain Hypothesis: How culture drives brain expansion, sociality, and life history. *PLoS Computational Biology*, 14(11), e1006504.
- Nelson XJ. (2014). Evolutionary implications of deception in mimicry and masquerade. *Current Zoology*, 60(1), 6-15.

- Nimuendajú, C. (1952). The Tukuna. In *The Tukuna*. University of California Press.
- Post RJ, Post CPK, and Walsh JF. (2009). Little Egret (*Egretta garzetta*) and Grey Heron (*Ardea cinerea*) using bait for fishing in Kenya. *Waterbirds*, 32(3), 450-452.
- Schultze, L. (1907). *Aus Namaland und Kalahari* (pp. 496-498). Jena: Gustav Fischer.
- Schwartz J-L, Basirat A, Ménard L, and Sato M. (2012). The Perception-for-Action-Control Theory (PACT): A perceptuo-motor theory of speech perception. *Journal of Neurolinguistics*, 25(5), 336-354.
- Schwartz J-L, Boë L-J, and Abry C. (2007). Linking dispersion-focalization theory and the maximum utilization of the available distinctive features principle in a perception-for-action-control theory. In M. J. S. P. S. Beddor, & M. Ohala (Eds.), *Experimental Approaches to Phonology* (pp. 104-124). Oxford University Press.
- Serpenti, L. M. (1965). *Cultivators In The Swamp: Social Structure And Horticulture In A New Guinea Society (Frederik-Hendrik Island, West New Guinea)*. Assen: Van Gorcum.
- Seyfarth RM, and Cheney DL. (2010). Primate vocal communication. In M. L. Platt, & A. A. Ghazanfar (Eds.), *Primate Neuroethology* (pp. 84-97). Oxford University Press.
- Seyfarth, R. M., & Cheney, D. L. (2013). Affiliation, empathy, and the origins of theory of mind. *Proceedings of the National Academy of Sciences*, 110, 10349-10356.
- Shepard P. (1998). *Thinking animals: Animals and the development of human intelligence*. University of Georgia Press.
- Steele MA, Halkin SL, Smallwood PD, McKenna TJ, Mitsopoulos K, and Beam M. (2008). Cache protection strategies of a scatter-hoarding rodent: do tree squirrels engage in behavioural deception? *Animal Behaviour*, 75(2), 705-714.
- Tippin, T. C. (2017). Propensity of predator mimicry in wild Steller's jays: Humboldt State University.
- Turnbull, Colin M. (1965). *Wayward Servants: The Two Worlds Of The African Pygmies*. Garden City, N.Y.: The Natural History Press.
- Wallace, B. (1973). Misinformation, fitness, and selection. *The American Naturalist*, 107(953), 1-7.
- Whiten, A., & Byrne, R. W. (1988a). The Machiavellian intelligence hypotheses: Editorial. In R. W. Byrne, & A. Whiten (Eds.), *Machiavellian intelligence: Social expertise and the evolution of intellect in monkeys, apes, and humans* (pp. 1-9). Clarendon Press/Oxford University Press.
- Whiten A, and Byrne RW. (1988b). Tactical Deception in Primates. *Behavioral and Brain Sciences*, 11(2), 233.
- Wignall AE, and Taylor PW. (2011). Assassin bug uses aggressive mimicry to lure spider prey. *Proceedings of the Royal Society B: Biological Sciences*, 278(1710), 1427-1433.
- Willerslev R. (2004). Not animal, not not-animal: hunting, imitation and empathetic knowledge among the Siberian Yukaghirs. *Journal of the Royal Anthropological Institute*, 10(3), 629-652.

Willerslev R. (2007). *Soul hunters: hunting, animism, and personhood among the Siberian Yukaghirs*: Univ of California Press.

Wood BM, Pontzer H, Raichlen DA, and Marlowe FW. (2014). Mutualism and manipulation in Hadza–honeyguide interactions. *Evolution and Human Behavior*, 35(6), 540-546.