

Aggressive Mimicry and the Evolution of the Human Cognitive Niche

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Abstract (150-250 words):

The evolutionary origins of deception and its functional role in our species is a major focus of research in the science of human origins. Several hypotheses have been proposed for its evolution, often packaged under either the Social Brain Hypothesis, which emphasizes the role that the evolution of our social systems may have played in scaffolding our cognitive traits, and the Foraging Brain Hypothesis, which emphasizes how changes in the human dietary niche were met with subsequent changes in cognition to facilitate foraging of difficult-to-acquire foods. Despite substantive overlap, these hypotheses are often presented as competing schools of thought, and there have been few explicitly proposed theoretical links unifying the two. Utilizing cross-cultural data gathered from the Human Relations Area File, we identify numerous ($n = 357$) examples of the application of deception towards prey across 145 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 as a tactic for deceiving conspecifics, 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):

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Statements and Declarations

None.

Introduction

Deception is rarer in nature than honest communication (Dawkins & Krebs, 1978). There are benefits to deceiving others, and conversely, to being able to detect others' deception (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. Despite its rarity, the extensive use of deception has been noted as a hallmark of human cognition. In addition to the game theoretical question of how deception can arise and be maintained, there is a question which continues to puzzle evolutionary scientists: Why is it that humans, in particular, do it so well?

Many proposals argue that the fitness functions of some of our cognitive abilities – such as our ability to lie – are to manipulate and outmaneuver conspecifics, forming a so-called “Machiavellian Intelligence” (Whiten & Byrne, 1988a; Berczkei 2018; Lucas et al., 2018). This “Machiavellian Intelligence” refers to individuals' abilities to socially outmaneuver others to achieve a preferred outcome. 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, evolved to accommodate the cognitive demands associated with managing social relationships within our large social groups (Barton & Dunbar, 1997; Dunbar, 1998). In this account, increases in group sizes led to the selection for novel cognitive faculties that improved relative abilities to socially compete and cooperate within these increasingly complex social systems. This hypothesis therefore argues that much of our cognition has been shaped by co-evolution with our conspecifics, which may have included the ability to lie (Byrne & Whiten, 1992).

Another popular hypothesis for the evolution of human cognitive traits is the foraging brain hypothesis proposed by Kaplan et al. (2000). Kaplan et al.'s posit that human cognitive prowess arose as a result of large-scale climatic shifts during the Pleistocene in which early humans shifted from a relatively easy chimpanzee-like foraging niche to a more cognitively demanding one. 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; our behaviors became more flexible to solve more challenging and variable problems in our environment with higher payoffs. Behaviors which may have arisen during this time include better memory and problem-solving, a greater reliance on social information from our conspecifics, and the emergence of food sharing and cooperation. While neither hypothesis should be taken as exclusive of the another, they differ in their points of emphasis and their relevance for the evolution of deception. Through the social brain hypothesis, we have an account which largely considers endogenous factors as relevant to the evolution of human cognitive traits, and through the foraging brain hypothesis, we have an account which is largely agnostic about deception altogether.

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 examples from non-human primates include 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); squirrels deceptively create false caches of food in the presence of conspecifics to prevent detection of real caches (Steele et al., 2008); and corvids have similarly been found to track the eyesight of other corvids 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 aggressive mimicry, predators “communicate with their prey by making signals to indirectly manipulate prey behavior” (Jackson & Cross, 2013). Common examples in nature include angler fish evolving appendages to entrap their prey, predatory species of firefly mimicking the lighting patterns of other species as lures, and carnivorous pitcher plants which attract and trap insects utilizing nectar (Nelson, 2014).

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-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 have been consistently observed and one comes from historical reporting. In the first case, field reports from multiple species of heron (family *Ardeidae*) and egrets (*Egretta garzetta*) show that these species employ an active form of bait-fishing in order to catch aquatic prey (Post et al., 2009). Displaying some form of delayed gratification, these birds are known to use a lure such as bread, feathers, or insects to entrance more desirable prey to the edge of the water where they can consume it. The second case comes from the relatively asocial shrikes (family *Laniidae*), which have been reported as far back as the medieval ages to exhibit a form of vocal mimicry of their prey (Atkinson, 1997). The nun Juliana Berners, author of the *Book of Saint Albans*, writing about shrikes in 1486 noted, “She will stand at perch upon some tree or poste, and there make an exceedingly lamentable crye.. All to make other fowles to thinke that she is very much distressed... 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 subtile fowle)...” Field experiments by Atkinson (1997) indicate that northern shrikes (*Lanius excubitor*) in Canada utilize acoustic mimicry to imitate the alarm calls of smaller birds in winter to lure them towards hidden perches. 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 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 the webs of prey, taking advantage of the wolf spiders’ own mechanism used to detect the presence of their own prey, potential mates, and rivals. Such cases have been documented in a wide array of other spiders including several jumping spider genera (*Brettus*, *Cyrtus*, and *Gelotia*) in the pirate spiders of the family *Mimetidae* (Jackson, 1992). Similar examples have also been described in spider-eating assassin bugs (Wignall & Taylor, 2011).

In addition to these habitual examples, other incidental examples of cognitive aggressive mimicry have been described. 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 pied tamarins (*Saguinus bicolor*), a claim further supported by field observations (de Oliveira Caldeira 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 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 utilize “hawk whistles” while hunting rabbits and squirrels by using a high-pitched whistle to mimic the sound of a hawk to freeze their prey in place (Angier & Young, 2016). 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).” Given the anecdotal accounts of aggressive mimicry among humans, a natural question which follows is to what extent this behavior is practiced across cultures. This study therefore seeks to assess the cross-cultural facets of deception towards prey and the evolutionary implications of such forms of deception.

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 (Narrol, 1967; Fischer & Ember, 2018). The sample itself is composed of ethnographic texts from 326 societies (at the time of this search) on every human-populated continent, 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 broad corpus research as querying specific terms will extract not only the term itself, but the entire document it is embedded within. Several caveats are worth noting. While this method can be used to establish, at a minimum, the presence of a specific trend, generally speaking the questions of researchers who use the database for broad searches, as in our case, are not the same questions the ethnographers had in mind (if they had any) when collecting their data. While some ethnographers may have focused on hunting methods among a specific society and extensively recorded cases of deception against prey, others may have simply noted the practice in the course of other work. Thus, comparisons between societies about the scale of tactical deception should be avoided in addition to the assumption that a lack of evidence indicates a lack of these hunting methods.

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. With eHRAF’s system for querying searches, we used the items *deceiv**, *deception*, *decoy**, *imitat**, *lure**, *luring*, and *mimic**. As we were primarily interested in the transmission of false signals as opposed to cue withholding or masking, as in the case of camouflage, we avoided terms directly related to camouflage, hunting blinds, and scent masking such as *trap*, *bait*, and *snare* (Lloyd 1983; Bradbury & Vehrencamp, 1998). 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. 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 fishing samples consist of different forms of baiting where the sensory context may not be necessarily comparable between terrestrial and aquatic modalities (i.e. to avoid the question of whether, from the perspective of the hunter, fish and birds perceive acoustic or baited signals the same “way”), 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 tambaquís (*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, “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 where was, “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 generally took the 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 is 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 animal, 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 Deceive* 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 did not describe aggressive mimicry, but contained specific references to cultural practices surrounding it. Of these nine, three (Andaman Islanders, Plains Omaha, and Amazonian Tukanos) had references to an absence of the practice or were ambiguous about its use. From the total 357 ethnographic examples, 145 cultures from 34 regions in all 7 continent groups had some form of aggressive mimicry. This represents roughly 44% of eHRAF’s cultural dataset at the time of this search. Given the limited use of key terms excluding those in additional contexts, such as in the use of traps or snares where additional examples of aggressive mimicry may have been found, the breadth of our sample is representative of only a minimum percentage of societies which practiced aggressive mimicry, with a true sample size which is likely larger than the 44% we identified.

The median unique forms of aggressive mimicry practiced by groups was three, with a range between one (n=55, 38% of the sample) and ten (n=1, < 1% of the total sample, among the Subarctic Ojibwa). 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... 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. 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 for deception.

Table 1: Sensory Exploitations for All Forms of Mimicry

Exploitation	Number	Percent
	133	37.3%
Visual	115	32.2%
Bait	45	12.6%
Fishing	21	5.9%
Mixed	21	5.9%

Fire Fishing	9	2.5%
Olfactory	7	2.0%
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 37% (n = 133) of all mimicry was acoustic, 32% (n = 115) was visual, 13% (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), 3% (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 = 283 out of 357) are reported in Table 2.

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

Exploitation	Number	Percent
Acoustic	124	43.8%
Visual	87	30.7%
Bait	40	14.1%
Mixed	20	7.1%
Olfactory	7	2.5%
Vibration	3	1.1%
?	2	0.7%

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

It is worth noting not all or even a grand majority of forms of fish exploitation involved direct line baiting. Examples include the use of shark rattles among the Melanesian Trobrianders and Santa Cruz Islanders and Polynesian Samoans; the construction of rat dummies amongst Samoans and 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. We found 53 examples of non-line baiting forms of fish sensory exploitations. 52% of these (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 entire sample:

Agro-Pastoralists (n = 11 examples, 3% of all examples), Commercial Economy (n = 1, < 1%), Horticulturalists (n = 61, 17%), Hunter-Gatherers (n = 155, 43%), Intensive Agriculturalists (n = 26, 7%), Other Subsistence Combinations (n = 58, 16%), Pastoralists (n = 17, 5%), and Primarily Hunter-Gatherers (n = 28, 8%). 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) breaking social systems down into foraging societies, horticultural societies, and pastoral and agriculture societies. As the social systems of pastoralists and agriculturalists are not necessarily dissimilar in terms of scale, we collapsed these two categories into one. We keep a distinction between horticulturalists and this group as they represent a middle state between a primary reliance on foraged foods and a primary reliance on agricultural products. This classification yielded the following three groups: hunter-gatherers (n = 183, 51%), horticulturalists (n = 61, 17%), and other subsistence types (n = 113, 31%). 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	37.2%
	Acoustic	65	35.5%
	Bait	24	13.1%
	Mixed	10	5.5%
	Fishing	7	3.8%
	Olfactory	5	2.7%
	?	2	1.1%
	Fire Fishing	2	1.1%
			100%
Horticulturalists	Acoustic	35	57.4%
	Visual	10	16.4%
	Bait	5	8.2%
	Mixed	5	8.2%
	Fishing	4	6.6%
	Vibration	2	3.3%
			100%
Other Subsistence Combinations	Visual	37	32.7%
	Acoustic	33	29.2%
	Bait	16	14.2%

	Fishing	10	8.8%
	Fire Fishing	7	6.2%
	Mixed	6	5.3%
	Olfactory	2	1.8%
	?	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.

To what extent are the samples from our search representative of eHRAF's entire dataset more broadly? For cultures within our eHRAF search which were categorized as hunter-gatherers, the sample consists of exclusive hunter-gatherers (51 cultures) and *primarily* hunter-gatherers (14 cultures). Comparatively, eHRAF's database contained 58 total hunter-gatherer groups, meaning 51/58 (88%) had some form of aggressive mimicry. For eHRAF's "primarily hunter-gatherer" units, 14/26 (54%) had aggressive mimicry. For horticulturalists, roughly half of the examples had some form of aggressive mimicry (49%, 26/53), while 29% (54/189) of the remaining societies have examples of aggressive mimicry. Values for the representativeness of each subsistence type compared to the total number of societies of that subsistence type contained in eHRAF at the time of our search are contained in Table 4.

Table 4: Representativeness of Sample by Subsistence Type

Subsistence Type	Appeared in Search	Displays Aggressive Mimicry	Total eHRAF Cultures
Hunter-Gatherer	52	51	58
Primarily Hunter-Gatherer	16	14	26
Horticulturalists	27	26	53
Other Subsistence Combinations	55	54	189
Total	150	145	326

Representativeness of each subsistence type based on a culture's appearance in our search, the presence/absence of aggressive mimicry in the examples obtained from the search, and the overall number of cultures of a specific type in eHRAF's dataset.

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 5. 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: 54% (n = 191) direct, 45% (n = 161) indirect, 1% (n = 4) which did not specify, and < 1% (n = 1) ambiguous.

Table 5: Directionality of Mimicry for All Forms of Mimicry

Directionality	Number	Percent
Direct	191	53.5%
Indirect	161	45.1%
?	4	1.1%
N/A	1	0.3%

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

Discussion

Our 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. While there is fair agreement that the human mind is and has been shaped through its interaction with the minds of other humans, be it through evolutionary, developmental, or cultural processes, much less is known about how it has been and continues to be shaped by the minds of non-human agents.

Following our discussion of the Social Brain Hypothesis and the Foraging Brain Hypothesis, we propose that the use of deception in hunting contexts could serve as a link between the different points of emphasis between the two theories. 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. The gap between the points of emphasis separating these two theories may be fertile grounds for theoretical exploration. As noted by Kaplan et al. (2000), “It seems likely that the cognitive ability associated with foraging in a complex three-dimensional environment is an important pre-adaptation for social intelligence and complex social relations.” By linking the use of these intraspecific traits to interactions with prey in order to acquire food, we provide one plausible link between foraging cognition and social cognition. 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 and larger brains and 2) longer lifespans to afford such expenses, as in the Foraging Brain Hypothesis (Kaplan et al., 2000). From this expensive brain came more plastic behaviors and domain general cognition providing humans with a “cognitive buffer” against less predictable environments (Sol, 2009), including the ability to copy the successful behaviors of others (Boyd & Richerson, 1996; Muthukrishna et al., 2018) and the 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 (ToM), or the recognition that other animals have mental states themselves, is often invoked in accounts of Machiavellian intelligence whereby ToM and other facets of human cognition arose through an evolutionary arms race. As group sizes increased and more complex patterns of group behavior emerged, those who were better at manipulating and deceiving others might have secured more resources for themselves (Dunbar, 1998; Whiten & Byrne, 1988a). However, deception towards conspecifics is rare in nature largely for the reason that as deceptive signals become more common, receivers are selected to become less attuned to them or evolve better detection mechanisms. This causes the benefits of transmitting deceptive signals to decrease. Hence, most communication between *conspecifics* tends to be cooperative and honest (Wallace, 1973; Dawkins & Krebs, 1978).

But outside of interactions with minds we cooperate with and the evolutionary pressures towards honest signaling are interactions with minds we do not cooperate with, as in the case 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, our use of deception may have been primarily geared towards non-conspecifics (Barrett, 1999). Early forms 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 show that most hunter-gatherer disguises in these groups were primarily used in the context of hunting, rather than being used for war (Buckner, 2021). The use of deception and the application of theory of mind towards other animals may have guided further forms of deception and fictioneering in general, such as in early animistic religions where agency 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 to higher nutrient, more difficult-to-obtain foods such as meat from other animals (Kaplan et al., 2000). During this period when humans began to explore a carnivorous niche, an increased consumption of fats and proteins allowed the human brain to evolve larger and simultaneously develop behavioral strategies to continue to feed itself (Bunn & Gurtoov, 2014). Among these behavioral strategies was 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 & Gurtoov, 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, or the ability to ascribe mental states in others, as in perspective-taking, mental-state attribution, or desire attribution (Krupenye & Call, 2019). Several examples from the literature compiled here explicitly reflect an understanding of animals' mindsets during deception. These range from more straightforward attributions of mental states, such as among the Guaraúno where, "to trap... means the same as to deceive the fish... spearing the fish by fooling him," (Turrado & Muiriden 1945) to explicit forms of perspective taking, as among the Yukaghir where one hunter notes, "You need to think like this: 'What would attract my curiosity as a sable?' This is how you need to think," (Willerslev, 2007) to complex human-like mental state attributions to animals and their spirits. Complex attributions include those noted by Dentan (1968) among the Semai, "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," and Jenness (1935) among the Ojibwa, "Animals are subject to deception no less than human beings, and the shadow of the deer (or moose) will be thrown off its guard, will believe that you are not engaged in hunting, and will fail to carry back a warning."

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. In primates, a limited number of signals can be perceived and employed in an almost limitless number of contexts. Nor is this unique to primates, as noted by Cheney and Seyfarth, “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 in its perception, but in its production (Cheney & Seyfarth, 1998; Fitch, 2011). A central remaining question for Seyfarth and Cheney (2010) then 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.

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 that, based on neurological evidence showing that humans actively take perceived sounds from the environment and develops them into pre-motor action, 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 vocal 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 ethnographic reports gathered from eHRAF, a number of records explicitly note regret and sympathy by hunters 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). Relatedly, Willerslev (2007) reports a Siberian Yukaghir hunter stating, “When killing an elk or a bear, I sometimes feel I’ve killed someone human. But one must banish such thoughts or one would go mad from shame.”

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 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 other 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, our own feelings regarding their 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. 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 them. 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 indicates that it would have yielded serious fitness benefits for early humans which were able to lure prey.

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 given more attention in future evolutionary research. We additionally recognize that mimicry and deception are not the full extent to which animal-human interactions may have played a role in developing our psyche, and that forms of cooperation and mutualisms likely played a role (Cram et al., 2022). Take for example the 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. The co-evolutionary relationship between hunters and birds is characterized by the manipulations of hunters, who destroy sources of honeycomb to increase the hunger motivations of the honeyguides, and the benefits received by both parties in a process described as “manipulative mutualism” (Connor, 1995; Wood et al. 2014). Such complex relationships have previously gone under described in both human and broader evolutionary contexts. We suggest that future research should therefore continue to explore the natural history of human-animal interactions observed in the field. Additional questions elucidating our own hypothesis may explore what human and

non-human interactions in the absence of theory of mind look like, as with cross-cultural development in children or with case studies such as the case of Temple Grandin, a researcher self-reportedly lacking theory of mind who has played an extensive role 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.

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