



Ecology, Domain Specificity, and the Origins of Theory of Mind: Is Competition the Catalyst?

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Abstract

In the nearly 30 years since Premack and Woodruff famously asked, “Does the chimpanzee have a theory of mind?”, the question of exactly how much non-human primates understand about the mental lives of others has had an unusually dramatic history. As little as ten years ago it appeared that the answer would be a simple one, with early investigations of non-human primates’ mentalistic abilities yielding a steady stream of negative findings. Indeed, by the mid-1990s even very cautious researchers were ready to flatly assert that Theory of Mind was a uniquely human capacity. Recently, however, an exciting new theoretical perspective on primate social cognition has arisen, and with it the distinct possibility that our evolutionary relatives may understand far more of the social world than we previously believed. In this paper we review new theory and evidence suggesting that non-human primates may indeed represent the mental states of others, at least within the domains for which their distinctive social ecology has prepared them. Having asserted that Premack and Woodruff’s original question can be answered with a qualified yes, we then consider the new questions that arise in its place, particularly how and why our own Theory of Mind became more domain-general than that of other primates.

The ability to reason about others’ behavior in terms of causal but unobservable psychological states is surely one of the most central aspects of our human cognitive experience. From as early as nine months of age human infants already interpret the actions of those around them in intentional terms (see Woodward, Sommerville, and Guajardo), and over the next few years of life this early mentalistic ability expands radically (see for example Meltzoff; Gergely, Bekkering, and Király). By approximately four years of age, normally developing humans possess a remarkably fluent capacity to reason about the perceptions, desires, goals, and beliefs (both true and false) of other individuals (see Saxe, Carey, and Kanwisher for an elegant review). Psychologists refer to this collection of social cognitive skills as *theory of mind* (ToM), a term that emphasizes its predictive function; from early childhood on, our interactions with others are largely driven by our use of ToM to draw inferences from imputed mental states to logically consistent predicted behaviors.

Given its importance in our own mental lives, the matter of exactly how *unique* this so-called mind-reading ability is remains one of the most provocative unanswered questions in modern psychology. As Premack and

Woodruff first put it, “Does the chimpanzee” – or any animal for that matter – “have a theory of mind?” The early history of non-human primate (hereafter, primate) ToM research did seem to support a simple response to this question. In a word: no. Having systematically reviewed all of the available evidence pertaining to primate social cognition, Tomasello and Call concluded that other primates appeared to have “no understanding of a psychological component [of behavior] in terms of the intentional and mental states of others” (387).

Tomasello and Call’s conclusion was not a rash one, supported as it was by a panoply of consistently negative findings. However, in the years that have since intervened, a new perspective on primate ToM has come to the fore, and with it the distinct possibility that earlier conclusions may not have done justice to primates’ true abilities. The cornerstone of this new approach is an emphasis on the ecological forces that shaped the minds of our evolutionary ancestors. Quite excitingly, this new ecological perspective has given primate researchers stronger theoretical traction both for re-evaluating the failures of the past and for asking old questions in new and more productive ways.

In this paper we review these new, ecologically motivated explorations of primate ToM. We first survey a representative sampling of primates’ prior failures at ToM tasks. These data are then compared to more recent findings in which primates have succeeded at conceptually (sometimes almost literally) identical tasks when they are embedded in more ecologically valid competitive contexts. This remarkable contrast is used to motivate some initial proposals regarding the social cognitive architecture of these animals.

The Case against ToM in Non-Human Primates

Experiments that have provided evidence against ToM in primates can be roughly divided into two categories: failures to understand others’ perceptual experience, and failures to attribute intentions to others. In this section we survey only the first of these bodies of evidence, focusing on primates’ inability to appreciate the connection between seeing and knowing.¹ The seeing/knowing question is particularly important because of the extent to which our own day-to-day social cognition hinges on a sophisticated understanding of the visual perception of others.² Primates, in contrast, have classically seemed ignorant of the importance of others’ eye gaze. Povinelli and Eddy (“Factors Influencing Young Chimpanzees’ Recognition”), for example, taught chimpanzees to use a begging gesture to request food from an experimenter standing outside their enclosure. Chimpanzees were then presented with a situation in which two experimenters were present, each with a different constraint on their visual perception; the chimpanzees’ task was to select the experimenter who could actually see their begging gesture. While chimpanzees could eventually be trained to choose correctly in the simple case of one experimenter facing forward and one facing

backward, they failed at even marginally more subtle discriminations. They did not differentiate between an experimenter wearing a blindfold over her eyes versus one wearing a blindfold over her mouth, or between one with a bucket over her head versus one holding a bucket beside her head. Primate researchers interpreted these and analogous experiments with rhesus monkeys (Povinelli, Parks, and Novak) as evidence that primates simply did not understand the connection between looking at an object and subsequently having knowledge of that object. Primates, it seemed, did not interpret gaze in terms of what it might indicate about underlying mental states.

A second class of seeing/knowing failures derive from experiments based on the so-called object-choice task. In the prototypical object-choice experiment, subjects are presented with two opaque containers and must use simple social cues provided by an experimenter to determine which container contains hidden food. Numerous studies (e.g. Anderson, Sallaberry, and Barbier; Call, Hare, and Tomasello; Call, Agnetta, and Tomasello; Itakura, Agnetta, Hare, and Tomasello; Peignot and Anderson; see review in Tomasello and Call) found that most primates failed to reliably select a container pointed to be a knowledgeable experimenter – one who actually saw the baiting of the containers – over a container indicated by an ignorant experimenter who did not see where the food was placed (see also Heyes for commentary). Again, even with training, primates appeared not to consider the visual perceptions and corresponding mental states of others.

Lack of Ability versus Lack of Generality: How the Notion of Domain Specificity Argues for Caution in Interpreting Prior Negative Findings

Though the accumulation of negative results such as those just described have at times made it seem virtually certain that primates lacked ToM, this finding has always been a rather surprising one. It seems clear after all that primates' ecological niche is one that places pre-eminent importance on social problem-solving. Indeed, as Tomasello and Call have pointed out, most comparative psychologists would agree that “the most complex cognitive problems faced by primates arise mostly in the social domain” (187). While it is true that primates could potentially make useful predictions and judgments about the behavior of others in a non-mentalist way, the adaptive advantages inherent in even a rudimentary ability to reason about the mental states of conspecifics certainly seems to constitute a formidable evolutionary pressure. We are thus left with a very important unresolved question. How is it that problems of a social nature play such a central role in the day-to-day cognition of primates, yet they appear to go unaddressed in terms more abstract than observable behavior? The answer, we argue, rests on the notion of domain specificity.

The basic concept of domain specificity was perhaps best summarized by Hirschfeld and Gelman: “domain specificity is the idea that all concepts are not created equal, and that the structure of [human] knowledge is different

in important ways across different content areas” (xiii; see also 3–35 for a more detailed overview). The mind, in other words, is conceptualized not as a single massively general learning architecture, but rather as a collaborative assemblage of specialized representations and algorithms, each of which is tailored to the demands of problem-solving in a specific domain. Further, the domains of knowledge that give rise to the mind are posited to be logically coherent in view of persistent evolutionary pressures – particularly those that would be unforgiving of attempts to adapt in an incremental trial-and-error fashion (Santos & Caramazza). That is, because problem domains such as social interaction and the discrimination of nutritive food sources were particularly pressing for the survival and reproductive success of our ancestors, these domains accrued specialized forms of representation that permitted more fine-grained inference-making and more efficient learning.

From a domain-specific perspective, one might strongly suspect that the social nature of primates would have led to the evolution of specialized mechanisms for reasoning about social problems. This intuition, however, must be subject to the proviso that though primates are social creatures, they are not exactly sociable ones. While species vary in the extent of their intraspecific aggression, the social interactions of all primates are unified by a common subtext of competition over scarce resources. The very fact that primates live in social groups in the first place makes such competition all but unavoidable; there are simply no other possible outcomes when a group of conspecifics attempts to share an ecological niche at the same place and time. Indeed, as Hare has put it, often times “competition within groups is so intense and potentially costly to reproductive success that it has been a challenge for behavioral ecologists to develop theories of why primates might live in groups at all” (271).

For these reasons, a more refined domain-specific view of primate social cognition might predict that primates would have specialized mechanisms for reasoning about others’ behavior in only very particular circumstances – namely, within the context of competition. This insight reveals a very important flaw in prior ToM research: the experimental tasks used in most prior studies were tacitly based on the idea of social *cooperation* rather than competition. Consider the food begging paradigm that Povinelli and others have used to argue against the mentalistic competence of primates (e.g., Povinelli and Eddy, “Factors Influencing Young Chimpanzees’ Recognition”). In order for the subject to respond correctly in this sort of experiment, they must first infer that the experimenter intends to share food with them. Note that this inference is one based on cooperative intent, and thus differs greatly from the types of inferences primates would have used mind-reading abilities to make throughout their evolutionary history. It is thus possible that the pattern of failures that have been observed have less to do with primates’ social cognitive abilities per se, and much more to do with the manner in which we had asked them to demonstrate those abilities.

Our basic hypothesis is thus that primates *do* in fact possess specialized mechanisms for reasoning about the unobservable mental states of others, but that these mechanisms are domain-specific in a manner consistent with the ecological pressures that shaped their mental architecture. That is, we posit that primates may only be able to reason about the mental states of others *within the domain of social competition*. There is already a substantial body of new experimental evidence that lends credence to this view (see Hare and Tomasello for a discussion). In the remainder of this paper we will review some of this new evidence, and consider the possible implications of a competition-specific view of primate social cognition.

Primate Social Cognition in Competitive Contexts

Hare et al. recently developed a new paradigm for assessing what primates understand about the connection between gaze and mental states. The basic experimental scenario involved pitting a subordinate chimpanzee subject against a more dominant conspecific in a competition for food placed inside a central testing arena. In an initial experiment (Hare et al.), two pieces of food were present in the arena, one visible to both chimps and one situated behind an opaque partition such that it was only visible to the subordinate individual. Both chimps were then released into the testing arena simultaneously. The experimenters reasoned that if subordinate chimpanzees were sensitive to what their conspecific competitors could and could not see, they should exhibit a strong preference for approaching the hidden food rather than the food left out in plain view. This was indeed exactly what subordinate chimpanzees did. Hare, Call, and Tomasello (“Do Chimpanzees Know?”) then went on to ask whether chimpanzees understand that a conspecific’s visual perception can lead to an underlying mental state of *knowing*. To explore this, they introduced the clever variation of hiding a single piece of food on the subordinate’s side of an opaque barrier while the subordinate watched and the dominant either could or could not also observe. The result of this manipulation was that the subordinate subjects approached the hidden food significantly more frequently when the dominant had not observed the baiting process than when the dominant had seen where the food was placed. Even more impressively, subordinates were also significantly more likely to approach the hidden food when the dominant was *misinformed* as to its location (i.e., the food was re-hidden while the dominant’s view of the testing arena was temporarily occluded) than when the dominant was correctly informed. In essence, the subordinate chimpanzees seemed sensitive to the false belief of their competitors.

In the years since these original competition experiments, researchers have extended this work to new competitive situations and new forms of mentalistic reasoning (see Tomasello, Call, and Hare; Tomasello et al. for review). For example, chimpanzees reason successfully about what human competitors can and cannot see (Hare, Call, and Tomasello, “Chimpanzees

Deceive a Human”), successfully represent the intentions of a human experimenter in competitive situations, (Call et al.), and succeed in an object-choice task that involves competitive cues (Hare and Tomasello). Recent work has also shown that chimpanzees are not the only primates capable of reasoning about mental states in these ways. Like chimpanzees, monkeys tested in competitive paradigms reason successfully about what human competitors can and cannot see (Flombaum and Santos, “Rhesus Monkey”), understand what competitors can and cannot hear (Santos, Nissen, and Ferrugia), represent what competitors can and cannot know (Flombaum and Santos, “What Rhesus Monkeys Know”; Santos, Nissen, and Ferrugia), and recognize the intentions underlying a competitor’s actions (Lyons and Santos; Phillips et al.). To take one example, Flombaum and Santos (“Rhesus Monkey”) pitted semi-free-ranging rhesus monkeys against human competitors in a competitive foraging task. Two experimenters, each carrying a small platform with a grape attached, approached lone monkeys and then assumed different postures relative to their grapes. For example, one experimenter stood facing his grape while the second experimenter turned around such that he could not see his. Flombaum and Santos discovered that the monkeys strongly preferred stealing grapes from the experimenter who was facing away, thus manifesting an awareness of gaze. Follow-up experiments revealed that macaques were actually capable of distinguishing very fine-grained gaze cues in order to select the more hapless of the two human experimenters. For example, macaques approached an experimenter whose eyes were averted to the side in preference to an experimenter whose eyes were facing forward, notwithstanding the fact that both experimenters had exactly the same head and body orientation relative to the grape. Macaques also approached an experimenter who was holding an opaque barrier in front of his eyes in preference to an experimenter who was holding the same barrier in front of his mouth.

What is particularly compelling about Flombaum and Santos’s result is that it shows macaques succeeding at a task that maps very precisely onto the food begging experiments in which Povinelli and Eddy (“What Young Chimpanzees Know”) famously report chimpanzees failing. In terms of the cues provided relating to each experimenter’s visual perceptual state, the two experiments are quite literally interchangeable. (The conditions in which a barrier over the eyes is contrasted with a barrier over the mouth provide a particularly compelling illustration of this point, see Fig. 1). Indeed, the only significant difference between the two experimental tasks is not a property of the stimuli at all, but rather of the context in which they are presented. While Flombaum and Santos’s macaques succeed at a *competitive* interaction with the experimenters, Povinelli and Eddy’s chimpanzees fail at a *cooperative* interaction despite its identical stimuli configuration. Flombaum and Santos’s work thus provides a particularly clear datum in favor of the competition hypothesis.

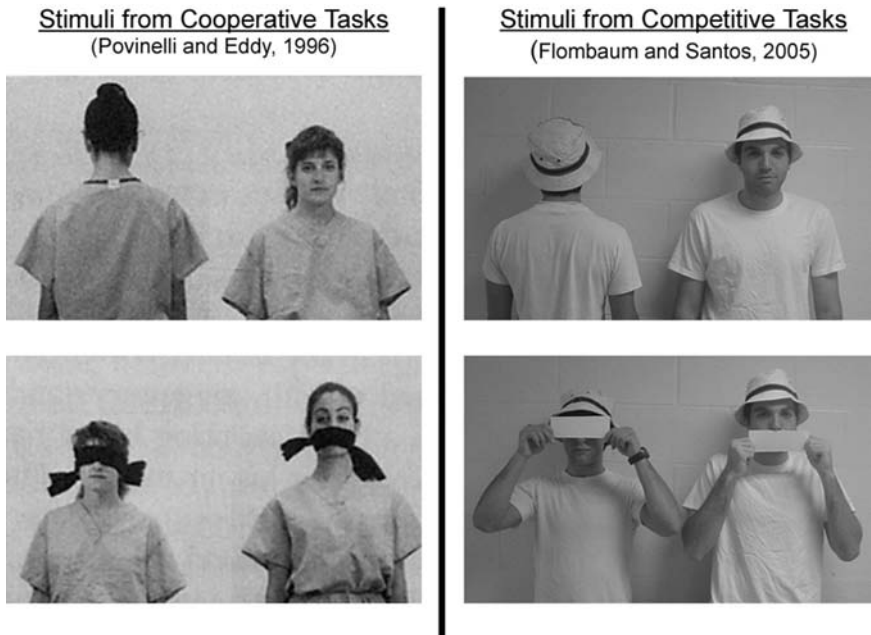


Fig. 1. Comparison of stimuli used in cooperative ToM tasks (left panel) and those used in competitive ToM tasks. Note the near identical similarity between the actual gaze stimuli employed across the two contextual domains.

Theoretical Implications of a Competition-Specific Theory of Mind

In this paper we have presented a highly suggestive disjunction in the literature on primate ToM. Early research found primates failing mentalistic tasks with great regularity. Primates did not appear capable of predicting the effect that visual perception would have on another individual's mental states, and did not show any ability to interpret another's behavior in intentional terms. The consensus view was that primate social cognition, though sophisticated, was based on sensitivity to observable behavior rather than to the psychological states mediating that behavior. In recent years, however, a new generation of studies has called this interpretation of prior negative results into question. When seeing/knowing and intention-reading ToM tasks are situated in competitive rather than cooperative contexts, primates suddenly become much more facile with mentalistic reasoning.

Several different interpretations of this context-dependency are possible. The least interesting alternative is that primates' better performance on competitive tasks is an experimental artifact. Perhaps primates really can reason about the mental states of others in a context-general way, and it just so happens that prior studies using cooperative paradigms were less sensitive to this ability than later competitive studies. While this lean interpretation of the data is an appropriate default hypothesis, we would argue that in this case there are several compelling reasons to dismiss it. First, the pattern of

negative results with cooperative tasks is a very robust one. Experiment after experiment found primates failing in cooperative settings, to the point that Tomasello and Call firmly ruled out the possibility that primates might have ToM in their influential late 1990s synthesis of the state-of-the-field. It is unlikely that such a robust pattern resulted from persistent overlapping flaws in experimental designs. Second and more importantly, the competitive experiments in which primates have shown mentalistic reasoning are uniformly quite similar to prior cooperative studies. As shown by the contrast between Flombaum and Santos's ("Rhesus Monkey") successful demonstration of seeing/knowing in rhesus macaques and Povinelli and Eddy's ("Factors Influencing Young Chimpanzees' Recognition") failed attempt to show the same ability in chimpanzees (Fig. 1), identical stimuli have yielded diametrically opposite results depending on whether they were embedded in a competitive or a cooperative social context. Thus, it is exceedingly unlikely that the evident context-dependency of primate mentalism is a spurious consequence of comparing radically different experimental designs.

Tomasello et al. have advanced a second hypothesis regarding the competitive/cooperative disjunction, this one centering on the notion of motivation. Tomasello et al. argue that humans find the sort of shared intentionality and joint attention that arises in cooperative social activities to be psychologically pleasurable in a way that other primates do not, and that this accounts for our seemingly unique ability to deploy ToM in non-competitive situations. According to this view, it's not that primates are in principle incapable of engaging in high-level social cognition in cooperative settings, it's just that they are very rarely motivated to do so. While we acknowledge this sort of motivational account as a possibility, we have argued elsewhere that there are several important problems with Tomasello et al.'s view (see Lyons, Phillips, and Santos). Most critically, the inherently subjective nature of motivation as an explanatory construct makes Tomasello et al.'s hypothesis exceedingly difficult to falsify. It is always possible, in other words, to argue that primates failed at a task because they were insufficiently motivated to apply abilities that they possess. Second, even if we accept a motivational premise, it is not clear to us why primates should find the same experimental task dramatically more motivating when it is presented in a competitive as opposed to cooperative context. For monkeys and apes, we would argue, a grape is a grape regardless of whether it is obtained from a friendly experimenter or stolen from an inattentive one. To presume that primates find the cooperative case so much less compelling than the competitive one that they show completely dichotomous abilities does not seem plausible.

We subscribe to a third hypothesis regarding the apparent context-sensitivity of primates' mentalistic reasoning. We believe that the observed pattern of results is neither coincidental nor the result of disparities in motivation, but rather a predictable consequence of the selective pressures that shaped the primate mind. More specifically, we argue that primates do indeed have access to the computational machinery necessary to represent

the intentions, perceptions, and even simple beliefs of other animate creatures. The critical feature differentiating primate ToM from our own is the fact that primate mentalism is strongly bound to the evolutionarily and ecologically salient domain of competition. Though this is a strong conclusion, it is one that we as well as others (e.g. Hare and Tomasello; Tomasello, Call, and Hare) believe to be amply supported by a significant diversity of new competitive studies.

The fact that ToM in primates appears to be so context-dependent does raise a host of very important theoretical questions, chief among those being why, at the level of computational mechanism, context-specificity might have occurred, and correspondingly how this context-specificity has been overcome in our own ToM. With regard to the first of these questions, we have already argued that the ecology of primates makes their mentalistic bias towards competition logically interpretable. At a deeper level, we would also like to observe that competitive social contexts have an important property that may serve to make them more mentalistically tractable than cooperative ones. Specifically, one of the axiomatic properties of competition amongst conspecifics is that it almost always involves two individuals who desire a limited resource for the same reason. When two primates contest food or reproductive access to mates, it is a safe assumption that they both have *the same basic intentions* with respect to the resource in question. Because of this commonality, a primate engaged in competition immediately has access to a powerful set of clues regarding the mental states of his competitor: namely, *his own mental states*. Mentalistic reasoning may have evolved first within the domain of competition because this built-in correspondence between the mental states of two competitors makes it much easier for both individuals to infer unobservable properties of the other, an idea that obviously echoes the simulation theory of ToM (e.g., Goldman; Gordon; Harris; Heal). On this view, it isn't that primates' mental state representations have properties that make them specific to competition per se, it's just that primates can only populate these representations with meaningful values when competition provides the necessary mentalistic crutch for doing so.

This brings us to our second question, that of how the context-specificity of primate ToM has been overcome in human social cognition. More specifically, if it is true that competitive situations are computationally simpler because of the reasonably direct mapping between competitors' mental states, then we need to address how it is that we do without the benefit of this mapping. One possibility that we would like to consider is that our unique linguistic system may play some role in this process. The idea that language may be critical for human-level ToM is not a new one, having been advanced in various forms by many other investigators (for illustrative examples see de Villiers; Tager-Flusberg; for concise discussion and review see Carruthers; Harris, de Rosnay, and Pons). For the purposes of our argument here, what we wish to point out is that because language allows us to assign representative symbols to things, it gives us a powerful ability

to reason about mental states that *differ* from those we are currently experiencing. Even if we are satiated, for example, we can reason about what it is like to experience hunger because the state label “hunger” has a rich set of associated bodily sensations and intentional propositions (hunger brings about the state of wanting food). It is as though the state label “hunger” provides an organizing principle by which we can populate all of our mental and physiological variables with values appropriate for simulating the condition of hunger, regardless of our own current state. The fact that primates lack language could thus mean that they are incapable of simulating – and hence inferring or reasoning about – mental states that differ significantly from their own present state, a restriction that would account for their specialized competence in competitive contexts. Note that the conjecture here is not that language as such makes our ToM qualitatively distinct from that of primates, but rather that language has given us a symbolic currency by which we can abstract away from our own present mental states in order to reason about the states of others in a more flexible and domain-general way.

In this paper we have argued that recent research dramatically revises the case in favor of primate ToM. Even though the opposite conclusion seemed all but certain ten years ago, the extant data now strongly support the position that primates *can* represent and reason about the mental states of others in sophisticated ways, subject to the proviso that such reasoning takes place in the context of social competition. Premack and Woodruff’s original question may be answered, but now the apparent context-specificity of primate social cognition generates a rich new set of unanswered questions for which novel theoretical as well as experimental tools will be necessary. Though we have provided some initial proposals here, the questions of why primate ToM evolved in a contextually limited way and how our own minds overcame this limitation will be immensely important ones in the work ahead. Our hope is that this piece will help to inform a robust debate about these questions within the philosophy community, a debate that may ultimately accelerate empirical discovery by providing a rigorous theoretical foundation for more incisive experimental work.

Notes

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¹ Readers interested in learning more about primates’ failures in classic intention reading tasks are encouraged to see Tomasello and Call for its encyclopedic account of relevant experiments with chimpanzees and other primates.

² Indeed, eye gaze appears to be one of the first aspects of the social world that infants attend to, following the gaze of adults in their environment from as early as three months of age (e.g. Butterworth; D’Entremont; Hood, Willen, and Driver) and soon extracting an impressive amount of information from this seemingly simple stimulus (see Baldwin; Baldwin and Moses).

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