WHY WE COOPERATE

Michael Tomasello

Based on the 2008 Tanner Lectures on Human Values at Stanford

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MICHAEL TOMASELLO AIMS TO EXPLAIN THE unique cognitive accomplishments of our species. He asks why we humans, alone among the earth's living creatures, transform our surroundings by tools and agriculture; why we analyze and codify our physical and social environment through the creation and study of history, geography, and social institutions; why we enrich our social and material world through a panoply of endeavors including literature and music, theater and sports, mathematics and science.

His work begins with two general observations. First, humans are primates. Our basic capacities for perception, action, learning, memory, and emotion show deep similarities with those of other apes, and considerable similarity to those of monkeys and more remote relatives. These similarities underlie the development of a host of new enterprises in neuroscience, genetics, evolutionary biology, and psychology: fields in which scientists gain insight into our own species through studies of other animals. Tomasello, in particular, has discovered commonalities among humans and other apes in our understandings of people and objects.[1] These similarities shed light on both the nature and the evolution of capacities at the foundations of our social and material lives.

Second, we do some bizarre things with our primate minds: humans engage in activities that no other animal contemplates. All animals must locate and identify food, for example, but only humans cultivate, herd, and cook. All animals must find their way to significant places in their environment, but only humans navigate by maps and ponder the geometrical structure of the universe far beyond any place to

which they could travel. Although many animals are sensitive to numerosity, only humans have a productive system of natural number concepts, organized around an iterative counting procedure. And while many animals must engage with other members of their own species in order to reproduce, raise their young, and organize their territory and its resources, only humans form complex social organizations such as schools, economies, factories, and armies. What sets humans on the paths that lead to these dramatic accomplishments?

To address this question, Tomasello and others have undertaken a threefold comparative approach to the study of human cognition. First, he and other students of animal cognition compare the cognitive capacities of different animal species, probing both for abilities and propensities that are widespread across animals and for those that are unique to primates, apes, or humans. Second, he and other students of human development compare the cognitive capacities of children of different ages, asking what capacities emerge earliest in development and what further achievements they allow. Tomasello's developmental research, in particular, illuminates a set of abilities and propensities that emerge at the start of the second year of life, remain present and functional at all later ages, and guide the development of a host of uniquely human cognitive achievements. Third, he and other linguists and anthropologists compare the cognitive achievements of children and adults in different cultures, so as to distinguish abilities and propensities that are universal across humans from those that depend on our cultural heritage and circumstances.

The earliest comparative approaches to the human mind were heavily criticized, in the last century, for positing a linear ordering from lower to higher animals, from simpler to more complex cognitive stages in humans, and from primitive to advanced cultures. But it is not clear that a linear model of change cannot work: phylogenesis, ontogenesis, and cultural development are rich and variegated. Tomasello and

other contemporary investigators use comparative approaches precisely because human cognition is so complex. To make progress in understanding it, we must carve cognition at its joints, breaking high-level capacities into parts whose properties and interactions can be described and manipulated. Moreover, we must distinguish between the abilities that truly stand at the foundations of humans' distinctive cognitive capacities and the further abilities that these foundations support. Contemporary cognitive scientists use comparisons across species, ages, and human groups to find both the evolutionarily ancient foundational capacities we share with other species and the capacities that distinguish us as a species, that arise early in human development, and that show the greatest invariance across human cultures.

These threefold comparisons cast doubt on a number of venerable ideas about the sources of human uniqueness. For example, one idea places the capacity for tool use at the foundations of human cognitive achievements. Tomasello's studies of chimpanzees and children reveal, however, that while tool use is an important indication of our distinctive capacities, it is not their source. Distinctively human patterns of tool use arise only after the emergence of uniquely human forms of communication.[2] A second idea views humans as "the symbolic species"[3] that naturally extends its cognitive capacities by means of maps, pictures, writing systems, and other symbols. But research in developmental psychology suggests that children only begin to understand such symbols in the third year of life,[4] long after the uniquely human developments that Tomasello describes in these chapters. A third idea focuses on the capacity for abstraction: humans are uniquely able to form and manipulate abstract concepts that enable, for example, the development of mathematics. Research in animal cognition, however, has found abstract numerical representations in a wide range of nonhuman animals.[5] And both developmental and cross-cultural studies further undermine the abstract-thought thesis by revealing that some of our most important abstract

concepts, such as the system of natural numbers, emerge after, and depend upon, the acquisition of language and verbal counting.[6]

So what are the innate differences between humans and other animals that give rise to humans' unique accomplishments? Tomasello's answer has changed in some ways over time,[7] a sign of his openness and productivity. The elegant experiments that he and his students have conducted have taught us that a number of perfectly sensible ideas about human nature turn out to be wrong. Despite these changes, however, a common theme runs through his work: the key to our unique nature resides in our distinctive social relationships. In these pages, Tomasello argues that the unique features of human cognition are rooted in an evolved, species-specific capacity and motivation for *shared intentionality* that gives rise to distinctive kinds of communication and joint action. Humans, on this view, are naturally driven to cooperate with one another and to share information, tasks, and goals. From this capacity spring all of our other distinctive achievements, from tool use to mathematics to symbols.

I think Tomasello's hypothesis has a chance of being right, but at least one competitor is alive and well: the view that human language is the source of our unique cognitive achievements. This view gains support, in part, from research that begins with younger human infants. Like Tomasello, I probe for the sources of human uniqueness by comparing cognitive capacities across species, ages, and cultures. I focus, however, on cognitive capacities manifest in the first months of human life, asking whether they exist in other animals, and what happens to them over the course of human development in our own and other cultures.

To summarize a few decades of experiments, I believe there is evidence for at least five cognitive systems in young infants: what I call systems of *core knowledge*.[8] These are systems for representing and reasoning about (1) inanimate, material objects and their motions, (2) intentional agents and their goal-

directed actions, (3) places in the navigable environment and their geometric relations to one another (4) sets of objects or events and their numerical relationships of ordering and arithmetic, and (5) social partners who engage with the infant in reciprocal interactions. Each of these cognitive systems emerges early in infancy (in some cases, at birth) and remains present, and essentially unchanged, as children grow. Thus, the systems are universal across our species, despite the many differences in the practices and belief systems of people in different cultural groups. Most important, these core knowledge systems are relatively separate from one another and limited in their domains of application. Children and adults bring them together, and overcome their signature limits, when they learn and practice later-developing, culturally variable, and uniquely human cognitive skills. These later developments, in turn, are related to children's acquisition of a natural language.

The core system for representing objects illustrates these findings. When infants in the first six months of life are presented with objects under controlled conditions, their spontaneous reactions of looking or reaching to the objects shed light on both the nature and the limits of their object representations. These experiments reveal that even newborn infants share some mature human capacities for representing objects: when tested under the right conditions, infants keep track of visible objects, infer what hidden parts of objects look like, and even represent objects that have been moved fully out of view.[9]

Nevertheless, infants' object representations show some quirky limitations. As adults, we can single out many different kinds of things, including cups, doorknobs, sand piles, trees, and towers made of blocks. Presented with each of these kinds of entities, however, infants represent only those that are internally cohesive and separately movable: the cups but not the doorknobs, sand piles, or block towers.[10] Infants also cannot keep track of more than three objects at any given time.[11] Most important, young infants fail to represent objects as members of kinds, with dedicated

functions. These limits serve as signatures that can indicate whether the core system continues to exist in adults in our culture and others, whether it is shared by other animals, and whether children and adults draw on this core system when they attempt to master new ways of thinking about the physical world. The answer to all of these questions is yes.

When adults follow visible objects about which we have little culture-specific knowledge, we show the same abilities that infants have, with the same signature limits.[12] Members of distant cultures perform the same object-representation tasks with similar results.[13] When older children begin to acquire names for objects, master counting, and reason about the mechanical interactions among objects, core notions of objects leave their imprint on each of these developments.[14] Infants' object representations therefore figure in the development of a host of uniquely human abilities.

Nevertheless, core object representations are not unique to humans. Semi-free-ranging rhesus monkeys form the same object representations, with the same signature limits as infants.[15] Research reveals common properties of these representations even in animals that are considerably more distant from humans, such as birds.[16] Core capacities for object representation therefore do not explain our unique human capacities for reasoning about the physical world: they account neither for our propensity for tool use nor for our capacity for formal science.

Even though infants' systems of core knowledge are not unique to humans, studies of these systems provide valuable tools for examining human cognition. Because our unique cognitive abilities build on core-knowledge systems that are shared by other animals, we can probe the development of these systems by studying other species, using the diverse, powerful techniques of neuroscience, genetics, behavioral ecology, and controlled rearing.[17] Moreover, we can study developing children and ask what distinguishes their uniquely human ways of representing objects from the core representations of younger infants and other animals.

Both human infants and adult monkeys can learn about the functional properties of specific objects—though slowly, in a piecemeal fashion.[18] Neither young infants nor adult monkeys, however, are rapid and flexible tool learners. In their second year of life, human children, and only human children, start putting together information about objects and actions productively. They come to view virtually every new object they see both as a mechanical body with a particular kind of form and as a potentially useful *tool* with a particular, dedicated function in the service of goal-directed action.

What accounts for this explosion of learning about artifacts? Recent research suggests children's artifact concepts have two sources: the core system of object representation just described and a second core system for representing agents and their goal-directed actions. From a very early age, human infants represent the actions of other people and animals as directed toward goals and as similar in purpose and form to the actions of the self.[19] Like core representations of objects, core representations of goal-directed actions are very similar in human infants and in nonhuman primates.[20] In their second year of life, however, human children start putting together information about objects and actions productively. The productive joining of object representations and action representations appears to be unique to our species, even though the core systems on which it builds are not.

What sparks the prolific development of tool concepts in children? Research from a number of sources suggests that this development depends in some way on children's learning of words as names for kinds of objects. This new linguistic format functions to join core representations. For instance, when infants learn their first object names, they put together information about object form and object function that previously was represented quite separately.[21] Object names also focus infants' attention on object categories: on what two different hammers or cups have in common.[22] Even adults who imagine

tool objects and their associated functions, such as hammering, activate secondary language areas of the brain: areas that may orchestrate representations of object structure and function.[23] Language—a combinatorial system par excellence—serves to combine representations of objects and actions rapidly, flexibly, and productively, giving rise to our prolific capacity to learn about and use tools.

I have focused on the development of tool use, but other distinctively human capacities appear to undergo a similar pattern of development. For example, human infants and other animals have a core system for representing numerosity, with its own distinctive limits—in particular, it is approximate and non-recursive—that preclude a full representation of natural numbers. Natural-number concepts emerge in the fourth or fifth year of life, when children learn number words, natural language quantification, and verbal counting: learning that leads them to combine their core representations of numerosity with their core representations of small numbers of objects.[24] As a further example, human infants and other animals have core systems for representing the shapes of two-dimensional forms and the shape of the large-scale, surrounding surface layout, but these systems are distinct and largely unrelated. In the third year, children begin to relate these systems through the use of language and thereby gain the ability to navigate by geometric maps.[25] Three hallmarks of uniquely human cognition—tool use, natural numbers, and geometry—appear to be consequences of a uniquely human combinatorial capacity that is linked to natural language.

When one considers these findings in relation to the research described by Tomasello, a natural question emerges: How does the human capacity for natural language, with the combinatorial power that it affords, relate to the human capacity for shared intentionality? Tomasello does not deny that language is an important, even crucial, cognitive tool for humans. He argues, however, that the acquisition of language itself requires an explanation, and our foundational capacity for shared intentionality provides it.[26] Language acquisition, in Tomasello's view, is not the product of a genetically specified language faculty. Instead, it is constructed by children over the course of their interactions with other people as they, and their social partners, focus jointly on objects and on one another. On this view, natural language is the product, not the source, of our uniquely human ways of cooperating and communicating.

It is possible, however, that the causal arrow points in the opposite direction. Uniquely human forms of shared intentionality may depend upon our uniquely human capacity for combining core representations productively. On this rival view, there are no uniquely human core systems in any substantive domain of cognition, including the domain of social reasoning. Only language has uniquely human core foundations, and it serves to represent and express concepts within and across all knowledge domains. Humans' unique ability to put together distinct core representations rapidly, productively, and flexibly may reside, therefore, in our innate faculty for language.

These two accounts—language as a product of uniquely human social interactions versus language as the source of those interactions—can best be distinguished by probing the origins of shared intentionality, through studies of younger infants. Young human infants are social in many ways. At birth, infants discriminate between different human people and attend to their direction of gaze.[27] Newborn infants also are sensitive to some correspondences between their own actions and the actions of other people, and they use this sensitivity to engage in an early form of imitation: they produce movements that are related to the movements they see.[28]

Crucially, however, none of these social capacities is unique to humans. Nonhuman primates are sensitive to faces even in the absence of prior visual experience,[29] they follow gaze to objects,[30] and they detect correspondences between their own actions and those of others even as newborns, engaging in patterns of imitation that are strikingly like those of newborn humans.[31] These findings suggest that our

core sociality—our interest in other people and our abilities to perceive and engage with them—is not unique to our species.

Moreover, the core system for understanding other people as social partners appears to be quite disconnected from the core system for understanding other people as goal-directed agents. Although young infants (and other animals) view other members of their species both as agents who act on objects and as partners who share their mental states, there is no evidence that they combine these notions flexibly or productively. Failures to combine representations of actors and social partners could explain why nonhuman animals and young infants do not treat other people as communicators and collaborators, whose goal-directed actions can be coordinated with their own through patterns of cooperation and shared attention.

As Tomasello's research beautifully reveals, shared intentionality—the triadic relationship of the self both to a social partner and to the objects of goal-directed actions—emerges around the beginning of the second year of life. From that time onward, children point in order to convey information, they discern other people's intentions from the direction of their gaze, they infer other people's states of knowledge from their past actions and perceptions, and they help others to achieve their goals. Shared intentionality may well be an integrated system at these ages, but is it the keystone of human uniqueness, or is this communicative system constructed—like tools, natural numbers, and symbolic maps—from a combinatorial capacity that is more fundamental still, and that operates by conjoining preexisting core systems of knowledge through the use of language?

Existing research does not decisively answer this question, but some findings favor the latter view. On this view, we might expect shared intentionality to emerge piecemeal, as language is gradually learned and representations gradually combined, rather than as one innate, integrated whole. This appears to be the case. At ten months of age, when infants are in

the process of developing understanding of communicative actions such as pointing, and of states of social attention such as mutual gaze, these developments are not closely related: a child may master one of these domains while making little progress in the other.[32] Moreover, ten-month-old infants reliably follow a person's gaze to the object at which she is looking and look at an object to which she is reaching, but they fail to connect these two abilities so as to predict that a person will reach for the object to which she looks.[33] These findings suggest that young infants fail to integrate their understanding of people as actors with their understanding of people as perceivers who share their own experiences of the surrounding world. Therefore, shared intentionality emerges in pieces, as one might predict if the child's developing language served to connect her otherwise disparate cognitive capacities.

How might these two conceptions be integrated to form the triadic relationship between an infant, her social partner, and the objects that both perceive and act upon? Children may construct the triangle of shared intentionality at the end of the first year, by harnessing the power of natural language. Natural-language expressions may serve as the critical link between agents, social partners, and objects, because words have two faces: (1) they refer to objects and (2) they are a medium of social exchange. Just as children may become tool users by using natural-language expressions to combine productively their core representations of objects and agents, they may become intentional communicators and cooperators by using such expressions to combine productively their core concepts of agents and social partners. Distinctively human forms of communication and cooperation may depend on uniquely human combinatorial capacities.

I have focused my remarks on two different attempts to explain humans' unique cognitive capacities: Tomasello's notion of an innate, species-specific capacity for shared intentionality, and the notion of an innate, species-specific combinatorial capacity

expressed in natural language. At this time, we cannot know whether either of these accounts is correct. Nevertheless, I believe that Tomasello's findings have focused current thinking in a fruitful direction, and his methods provide a model for advancing our understanding.

To make further progress, however, investigators need to harness the kind of ingenuity Tomasello has shown in extracting insights from observations of one-, two-, or three-year-old children, and probe the sociality of younger infants, both human and nonhuman. As in the case of object representation, a panoply of methods, from neurophysiology to controlled-rearing studies, can be assembled to explore the earliest-emerging capacities for social knowledge.[34] Armed with a better understanding of humans' earliest-developing social knowledge, investigators can then explore the key developmental events that lead to the emergence, in the second year, of the remarkable patterns of communication and cooperation that Tomasello's work reveals. Experiments that enhance young infants' social or linguistic experience, and then assess the cognitive consequences of this enhancement, may be especially illuminating for this purpose.[35]

Whatever the outcome of these studies, Tomasello's work gives us reason to believe that the next decade of research exploring the minds and actions of infants will be as fruitful as the last. The fundamental questions of human nature and human knowledge, questions that have been outstanding for millennia, are beginning to yield answers, and I believe will now particularly bear fruit through comparative work with the youngest members of our species.