Michael Tomasello

Learning through others

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Learning is a biological adaptation. The majority of organisms on Earth learn little or nothing during their individual lifetimes. On the other hand, many mammals are born in a highly immature state and so they must individually learn things crucial for their survival. In order to find food reliably, youngsters of foraging species must learn the spatial layouts of their local environments. In order to distinguish friends from enemies, youngsters of social species must learn to recognize the individuals who make up their social groups.

For several decades, behaviorists attempted to find the laws of learning that applied equally to all species, for any and all tasks, and that did not involve to any significant degree processes of cognition. But the modern view that learning assumes diverse forms in different species and behavioral domains, and operates in concert with cognitive processes that may be specific to particular species or domains, has for the most part suspended that search.

For social species such as humans and other mammals, an especially important form of learning is social learning. Observing the activities of others and learning about the world from or through them enables individuals to acquire information with less effort and risk than if they were forced to learn on their own. For instance, many species of rats learn which foods to eat and which to avoid by observing what other rats eat and then seeing what happens to them subsequently – clearly a safer strategy than always trying out new foods for oneself.[1]

Despite an overall similarity in the function of learning in the lives of different species of mammals, social learning, like individual learning, comes in many different forms. In our empirical work over the past fifteen years, we have investigated forms of social learning that

Michael Tomasello is codirector of the Max Planck Institute for Evolutionary Anthropology and honorary professor of psychology at the University of Leipzig and at Manchester University. His publications include "The Cultural Origins of Human Cognition" (1999), "The New Psychology of Language: Cognitive and Functional Approaches to Language Structure" (1998), and "First Verbs: A Case Study of Early Grammatical Development" (1992).

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1 Bennett G. Galef, Jr., "Social Influences in Food Choices of Norway Rats and Mate Choices of Japanese Quail," *International Journal of Comparative Psychology* 14 (1 – 2) (2001): 1 – 24.

human beings share with other primate species, as well as forms that are uniquely human. The unique forms mostly derive, we believe, from some social-cognitive processes that only humans possess.[2]

In brief, because human beings perceive the behavior of others in intentional terms – that is, because they perceive a person 'cleaning the table' or 'opening the drawer,' rather than simply moving her limbs in a particular way – they learn from the behavior of others in unique ways. We have called this process 'cultural learning' to distinguish it from processes of social learning in general, and also to highlight the crucial role of culture in the acquisition of many human skills. My colleagues and I have distinguished three kinds of cultural learning: imitative learning, instructed learning, and collaborative learning.[3] The ability of individuals to imagine themselves in the 'mental shoes' of other people, to understand conspecifics as beings like themselves who have intentional and mental lives like themselves, enables these types of cultural learning. Most of our empirical work has focused on only one type of cultural learning – imitation in children before about two years of age. So that will be my focus here.

The recognition of others as intentional beings like oneself is crucial in human learning, most importantly because artifacts and practices – exemplified prototypically by the use of tools and linguistic symbols – invariably point beyond themselves to the phenomena for which they have been designed. To learn the conventional use of a tool or a symbol, an individual must therefore come to understand why, toward what outside end, another individual is using it.[4]

Chimpanzees, humans' nearest primate relatives, do not learn from one another in this same way. In 1996, I reviewed all of the experimental studies of chimpanzee tool use, and I concluded that chimpanzees are very good at learning from others about the dynamic affordances of objects, but are not skillful at learning from others new behavioral strategies or intentional activities per se.[5] For example, if a mother rolls over a log and eats the insects underneath, her child will very likely follow suit. From her mother's act the child has learned that there are insects under this particular log – but she did not learn from her mother how to roll over a log or how to eat insects; she could have learned these on her own. Thus the youngster would have learned the same thing if the wind, rather than her mother, had exposed the ants under the log. This is an instance of 'emulation learning,' which concerns changes of state in the environment rather than a conspecific's intentional activity or behavioral strategy.

In some circumstances, emulation learning is a more adaptive strategy than learning by imitation. For example, Kathy Nagell, Kelly Olguin, and I presented chimpanzees and two-year-old human children with a rake-like tool and

2 Michael Tomasello, Ann C. Kruger, and Hillary H. Ratner, "Cultural Learning," *Behavioral and Brain Sciences* 16 (1993): 495 – 552; Michael Tomasello, "Do Apes Ape?" in Cecilia M. Heyes and Bennett G. Galef, Jr., eds., *Social Learning in Animals: The Roots of Culture* (San Diego, Calif.: Academic Press, 1996); Michael Tomasello, *The Cultural Origins of Human Cognition* (Cambridge, Mass.: Harvard University Press, 1999).

3 Tomasello, Kruger, and Ratner, "Cultural Learning."

4 Tomasello, *The Cultural Origins of Human Cognition.*

5 Tomasello, "Do Apes Ape?"

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an out-of-reach object.[6] The tool could be used in either of two ways leading to the same end result of obtaining the object. Within each species, one group of subjects observed a demonstrator employ a relatively inefficient method of tool use, while another group observed a more efficient method of tool use. The result: human children in general copied the method of the assigned demonstrator (imitative learning), while chimpanzees used the same methods to obtain the object no matter which demonstration they observed (emulation learning). The interesting point is that many children insisted on reproducing adult behavior even if it seemed inefficient – leading to a less successful performance than that of the chimpanzees. Imitation is thus not a 'higher' or 'more intelligent' learning strategy than emulation; it is simply a more culturally mediated strategy – which, in some circumstances and for some behaviors, has some advantages.

Chimpanzees are very creative in using tools, and intelligent about understanding changes in the environment brought about by the tool use of others. But they do not seem to understand the instrumental behavior of conspecifics in the same way as humans do. Humans perceive the demonstrator's apparent intention as centrally important, and they understand this goal as something separate from the various behavioral means that may be used to accomplish it. In the absence of this ability to understand goal and behavioral means as separable in the actions of others, chimpanzees focus on the changes of state (including changes in the spatial position) of the objects during the demonstration, perceiving the actions of the demonstrator just, in effect, as other physical motions. The intentional states of the demonstrator, and thus her behavioral methods as distinct entities, are simply not a part of their experience.

A similar story may be told about the gestural communication of chimpanzees. In a series of studies, we explored whether youngsters acquire their gestural signals by imitative learning or by a process of ontogenetic ritualization.[7] In ontogenetic ritualization, two organisms devise a communicatory signal through repeated instances of a social interaction. For example, an infant may initiate nursing by going directly for the mother's nipple, perhaps grabbing and moving her mother's arm in the process. So in some future encounter the mother might sense, and respond to, her infant's hunger at the first touch of her arm, leading the infant to abbreviate her signal for hunger even further the next time. This is presumably analogous to the way that most human infants learn the 'arms over head' gesture to request that adults pick them up – first as a direct attempt to crawl up the

6 Katherine Nagell, Raquel Olguin, and Michael Tomasello, "Processes of Social Learning in the Tool Use of Chimpanzees (*Pan troglodytes*) and Human Children (*Homo sapiens*)," *Journal of Comparative Psychology* 107 (1993): 174 – 186.

7 Michael Tomasello, Barbara George, Ann C. Kruger, Jeff Farrar, and Andrea Evans, "The Development of Gestural Communication in Young Chimpanzees," *Journal of Human Evolution"* 14 (1985): 175 – 186; Michael Tomasello, Deborah Gust, and Thomas Frost, "A Longitudinal Investigation of Gestural Communication in Young Chimpanzees," *Primates* 30 (1989): 35 – 50; Michael Tomasello, Josep Call, Katherine Nagell, Raquel Olguin, and Malinda Carpenter, "The Learning and Use of Gestural Signals by Young Chimpanzees: A Transgenerational Study," *Primates* 37 (1994): 137 – 154; Michael Tomasello, Josep Call, Jennifer Warren, Thomas Frost, Malinda Carpenter, and Katherine Nagell, "The Ontogeny of Chimpanzee Gestural Signals: A Comparison Across Groups and Generations," *Evolution of Communication* 1 (1997): 223 – 253.

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adult's body, and then, as the adult anticipates the baby's desire and picks her up, as an abbreviated, ritualized version of this crawling activity performed for communicative purposes only.[8]

All available evidence suggests that ontogenetic ritualization, not imitative learning, is responsible for chimpanzees' acquisition of communicative gestures. Individual chimpanzees use a number of idiosyncratic signals that must have been individually invented and ritualized – a finding that longitudinal analyses have confirmed.[9] Significantly, captive youngsters raised in peer groups that have no opportunity to observe older conspecifics frequently use many of the same gestures that are common among other chimpanzee youngsters. In an experimental study, colleagues and I removed an individual from the group and taught her two different arbitrary gestures she could use to obtain desired food from a human.[10] When she returned to her group and used these signals to obtain food from a human, not even one chimpanzee reproduced either of the new gestures – even though all of the other individuals observed the gesturer and were highly motivated for the food.

Chimpanzee youngsters thus acquire the majority, if not the totality, of their gestures by individually ritualizing them with one another. The explanation for this learning process is analogous to the explanation for emulation learning in the case of tool use. Like emulation learning, ontogenetic ritualization does not require individuals to analyze the behavior of others in terms of ends and means in the same way as does imitative learning. Imitatively learning an arm touch as a solicitation for nursing would require that an infant observe another infant using an arm touch and understand that other infant's goal. Ritualizing the arm touch, on the other hand, only requires the infant to anticipate the future behavior of a conspecific in a context in which the infant already has the goal of nursing. Ontogenetic ritualization is thus, like emulation learning, a very useful learning process that is important in all social species – but it is not a learning process by which individuals attempt to reproduce the intentional activities or behavioral strategies of others; it is not cultural learning the way humans practice it.

Human beings begin to learn through imitation at around the first birthday. But it takes clever experimentation to distinguish the unique features of this form of learning from those of another. For example, if an adult takes the top off of a pen and a child then does the same, there are many possible explanations, including emulation and mimicking (copying movements without knowing what they are for). Researchers have therefore devised ingenious techniques for analyzing the different components of what the child perceives, understands, and reproduces in a demonstrated act.

For example, according to the technique Andy Meltzoff devised, fourteen-month-old infants saw an adult illuminate a box by bending down and touching her head to the top of it.[11] Although

8 Andrew Lock, "The Emergence of Language," in Andrew Lock, ed., *Action, Gesture, and Symbol: The Emergence of Language* (New York: Academic Press, 1978).

9 See Jane Goodall, *The Chimpanzees of Gombe: Patterns of Behavior* (Cambridge, Mass.: Harvard University Press, 1986).

10 Tomasello, Call, Warren, Frost, Carpenter, and Nagell, "The Ontogeny of Chimpanzee Gestural Signals."

11 Andrew Meltzoff, "Infant Imitation After a One-Week Delay: Long-Term Memory for

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infants could more easily have solved this task by emulation (e.g., by touching the box with their hand), they instead chose to use the same means as the adult, unusual as it was. These infants could have been mimicking the adult's unusual action without understanding the goal of turning on the light. But if they had been copying this action with the same goal in mind, their behavior would have been an instance of imitative learning.

In order to determine which of these two mechanisms was at work, Malinda Carpenter, Nagell, and I tested nine- to fifteen-month-old infants on a modified version of this task: we delayed the illumination of the light after the infants' reproduction of the action, and noted whether they looked in anticipation to the light.[12] We found that infants twelve-months and older looked to the light in anticipation before it came on. If the light did not come on, they often repeated their action or looked quizzically to the people in the room. This suggests that they were adopting the adult's means in order to achieve the same goal of turning on the light. Infants thus were not just mimicking the adult's action, but were engaging in imitative learning of a novel means to achieve a perceived end.

In another experiment, infants were shown identical actions that produced identical results, but with different expressed intentions. Carpenter, Nameera Akhtar, and I showed fourteen- to eighteen-month-olds a series of two actions on objects.[13] For each object, the pair of actions was followed by a striking result – the sudden illumination of colored lights, for example. In the key experiment, one of the demonstrator's paired actions was marked verbally as intentional ("There!") while the other was marked verbally as accidental ("Woops!"), but otherwise the actions looked very similar. Instead of mimicking both of the actions they observed, even the youngest infants reproduced the action marked as intentional significantly more often than the one marked as accidental.

Another study demonstrated that infants were able to imagine the goal toward which the adult was acting, even though they never actually saw any concrete results. In a 1995 experiment, Meltzoff showed eighteen-month-olds an adult either successfully completing a task (pulling apart two halves of a dumbbell) or trying but failing to do so (because the adult's hands slipped off the ends of the dumbbell). Infants were able to complete the task whether or not they had seen an adult successfully complete it. Yet these eighteen-month-olds were not able to achieve the same result when they watched a machine either successfully completing the same task or trying, or failing, to do so. Francesca Bellagamba and I replicated the basic findings of this study with twelve- and eighteen-month-old infants, but we found that twelve-month-olds could not reproduce the adult's intended action when they only saw her trying unsuccessfully to perform it.[14]

Novel Acts and Multiple Stimuli," *Developmental Psychology* 24 (1988): 470 – 476.

12 Malinda Carpenter, Katherine Nagell, and Michael Tomasello, "Social Cognition, Joint Attention, and Communicative Competence from 9 to 15 Months of Age," *Monographs of the Society for Research in Child Development* 63 (4) (1998).

13 Malinda Carpenter, Nameera Akhtar, and Michael Tomasello, "Sixteen-Month-Old Infants Differentially Imitate Intentional and Accidental Actions," *Infant Behavior and Development* 21 (1998): 315 – 330.

14 Francesca Bellagamba and Michael Tomasello, "Reenacting Intended Acts: Comparing

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Other studies have manipulated the social learning context in an effort to influence what behavior children reproduce and so gain insight into what they interpret as intentional action. Using Meltzoff's study as a starting point, George Gergely, Harold Bekkering, and Ilday Király showed fourteen-month-olds an adult touching her head to the top of a box to turn on a light.[15] In their study, half of the infants saw the adult turn on the light while her hands were occupied (she was holding a blanket around her shoulders), and half saw her turn it on while her hands were free. Infants who saw the hands-free demonstration touched the box with their heads significantly more often than infants who saw the hands-occupied demonstration. Infants thus used the context of the situation to interpret the adult's behavior, appearing to assume that if the adult's hands were free and she still chose to use her head, then there must be a good reason for this choice. Meanwhile, the infants who saw the other demonstration apparently interpreted the use of her head as necessary given her circumstances (and so as an inessential part of her intention), and thus did not reproduce this action. These infants' interpretation of the adult's goal thus differed across conditions: in the hands-occupied condition her apparent goal was 'turn on the light'; in the hands-free condition it was 'turn on the light with your head.' By fourteen months, infants thus evidence a very deep understanding of intentional action, of how it relates to the surrounding context, and of what this means for their own choice of a behavioral means in similar or different circumstances.

A series of studies of older children extends these findings. For example, Bekkering and his colleagues showed three- to six-year-old children an experimenter touching a table in one of two locations.[16] In one condition there were dots on the table in those locations, and in another condition there were no dots. In the no-dot condition, children usually matched the adult's behavior exactly, even copying her crossed or straight arm positions – presumably because there was no other apparent goal to her actions than these arm movements. In the dot condition, however, children touched the same locations as the experimenter, but often did not match her exact arm positions. This is presumably because when there were dots they interpreted the adult's goal as 'touching the dots,' whereas when there were no dots the only possible goal seemed to be 'moving one's arms like this.' Bekkering and his colleagues concluded that young children's imitation is guided by their understanding of adults' goals and of the hierarchy of those goals, and that children imitate what they perceive the adults' main goal to be.

Subsequent studies have confirmed that children use context to interpret adults' actions, and that this influences what they learn. In one study, an adult demonstrated to five groups of children how to pull out a pin and open a box.[17]

12- and 18-Month-Olds," *Infant Behavior and Development* 22 (1999): 277 – 282.

15 György Gergely, Harold Bekkering, and Ildikó Király, "Rational Imitation in Preverbal Infants," *Nature* 415 (2002): 755.

16 Harold Bekkering, Andrew W. Wohlschlaeger, and Merideth Gattis, "Imitation of Gestures in Children is Goal-directed," *Quarterly Journal of Experimental Psychology* 53A (1) (2000): 153 – 164.

17 Malinda Carpenter, Josep Call, and Michael Tomasello, "Understanding Others' Prior Intentions Enables 2-Year-Olds to Imitatively Learn a Complex Task," *Child Development* 73 (2002): 1431 – 1442.

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What differed among the groups was what the children experienced just prior to this demonstration. One group of children received information about the adult's goal ahead of time; another group received none; the three other groups received varying amounts of information about the adult's goal. In the demonstration, the adult either tugged unsuccessfully on the door of the box, or showed the box already open, or visited and opened three different boxes before demonstrating how to open the test box. Thus all of the children in all of these conditions saw a full demonstration of how to open the box, but only the children in the three prior-information conditions could know what the adult was about to do before she began this demonstration. Two- and two-and-a-half-year-old children were significantly better at opening the box themselves when they knew the adult's goal ahead of time. In this study, then, children interpreted the exact same behavior differently depending on whether they knew the adult's goal ahead of time – with no concurrent cues in adult emotional expression or the like. In other words, in the control conditions the children were not able to provide an intentional description of 'what the adult is doing,' whereas in the prior information conditions they were able to understand the behavior as the intentional action 'trying to open the box.'

There are some kinds of actions that children observe and attempt to imitate that have a special structure because they involve people having goals toward one another reciprocally. For example, a mother might blow a raspberry along her child's arm; if the child wants to imitate this behavior, she is faced with a choice that depends on how she interprets her mother's action. Thus, she might blow a raspberry along her own arm, in exactly the same place her mother did, or alternatively, she might blow a raspberry along her mother's arm – interpreting the behavior in this case reciprocally as 'blowing on the partner's arm.' I have called this 'role reversal imitation.' In an ongoing study, my colleagues and I have found that eighteen-month-olds are more likely to employ this reciprocal interpretation than are twelve-month-olds. At both ages, children are more likely to reciprocate in the situation where the adult, for example, pats her own head (and the child pats his own), than in the case where the two partners act on one another.

A similar process occurs in the learning of language, since learning to use linguistic symbols is also reciprocal. Thus, when an adult uses a linguistic symbol in a communicative act, she directs the child to attend to something. Consequently, to learn to use a symbol as the adult does, the child must learn to direct the adult's attention as the adult had directed the child's.[18]

Interestingly, my colleagues and I have recently offered evidence that something similar goes on in children's early symbolic play. Before two years of age, by watching adults children imitatively learn symbolic behaviors with objects, in much the same way that they learn instrumental actions with artifacts. As they grow older, they look to the adult more often, and in some cases smile more often, when producing the symbolic behaviors. This is evidence that children of this age are reproducing a special kind of intentionality – a kind of mutually reciprocal intentionality in which for the moment the child and the adult agree, for example, to treat a pencil as if it were a horse.

18 Tomasello, *The Cultural Origins of Human Cognition*.

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Given the general ability to learn a symbol through role reversal imitation, it is still the case that in learning particular words on particular occasions children often need to read the adults intentions in order to connect the word appropriately to its intended referent. Several language acquisition studies show that children as young as eighteen months can combine all of the types of intention reading we have discussed above while imitatively learning novel words. For example, in a study of twenty-four-month-olds, an adult announced her (prior) intention to find a target object by saying, "Let's go find the *toma*."[19] She searched through several buckets, extracting and rejecting with a scowl the novel objects inside. She then extracted another novel object with an excited expression and stopped searching. In a later comprehension test, when asked to go get the *toma* themselves, children chose the object the adult had identified as fulfilling her intention. This experiment used a modified procedure to show that twenty-four-month-old children could identify the intended referent even when the adult was unable to open the container with the target object inside – that is, when she had an unfulfilled intention. Another study investigated children's use of their understanding of intentional versus accidental actions when learning novel words. In a study of twenty-four-month-olds, the adult announced her (prior) intention to perform a target action by saying, "I'm going to *meek* Big Bird!" She then performed, in counterbalanced order, one accidental action, which she verbalized by saying "Woops!" and one intentional action, which she indicated by saying "There!" Later, when they were asked to *meek* a different character themselves, children performed the action that the adult had marked as intentional.

Like the studies of actions on objects, these word learning studies provide evidence that at a very early age children come to understand intentional action. And human learning is what it is – namely, cultural learning – because human beings, even when quite young, are able to understand the intentional and mental states of other human beings. Through this understanding, cultural processes take human cognition in some directions not possible in other species – and make human cognition an essentially collective enterprise.

19 Michael Tomasello and Michelle Barton, "Learning Words in Non-ostensive Contexts," *Developmental Psychology* 30 (1994): 639 – 650.

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