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Ape and Human Cognition: What's the Difference?

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Abstract
Humans share the vast majority of their cognitive skills with other great apes. In addition, however, humans have also evolved a unique suite of cognitive skills and motivations—collectively referred to as shared intentionality—for living collaboratively, learning socially, and exchanging information in cultural groups.

Keywords
apes, culture, cognition, evolution, cooperation

Surely one of the deepest and most important questions in all of the psychological sciences is how human cognition is similar to and different from that of other primates. The main datum is this: Humans seemingly engage in all kinds of cognitive activities that their nearest primate relatives do not, but at the same time there is great variability among different cultural groups. All groups have complex technologies but of very different types; all groups use linguistic and other symbols but in quite different ways; all groups have complex social institutions but very different ones. What this suggests is that human cognition is in some way bound up with human culture. Here we argue that this is indeed the case, and we then try to explain this fact evolutionarily.

Similarities in Ape and Human Cognition

The five great ape species (orangutans, gorillas, chimpanzees, bonobos, humans) share a common ancestor from about 15 million years ago, with the last three sharing a common ancestor from about 6 million years ago (see Fig. 1 for a picture of chimpanzees). Since great apes are so closely related to one another evolutionarily, it is natural that they share many perceptual, behavioral, and cognitive skills.

Great ape cognitive worlds

Many different studies suggest that nonhuman great apes (hereafter great apes) understand the physical world in basically the same way as humans. Like humans, apes live most basically in a world of permanent objects (and categories and quantities of objects) existing in a mentally represented space. Moreover, they understand much about various kinds of events in the world and how these events relate to one another causally (see Tomasello & Call, 1997, for a review). Apes' and other primates' cognitive skills for dealing with the physical world almost certainly evolved in the context of foraging for food. As compared with other mammals, primates may face special challenges in locating their daily fare, since ripe fruits are patchy resources that are irregularly distributed in space and time.

Other studies suggest that great apes understand their social worlds in basically the same way as humans as well. Like humans, apes live in a world of identifiable individuals with whom they form various kinds of social relationships—for example, in terms of dominance and "friendship"—and they recognize the third-party social relationships that other individuals have with one another. Moreover, they go beneath this understanding of social behavior and relationships to understand the goals and perceptions of social partners acting as intentional agents (see Call & Tomasello, 2008, for a review). Apes' and other primates' cognitive skills for dealing with the social world evolved mainly in the context of competition with groupmates for valued resources, and primates, as compared with other mammals, live in especially complex social groups (leading to so-called Machiavellian intelligence; Byrne & Whiten, 1988).

Great ape cognitive operations

Great apes also operate on their cognitive worlds in ways very similar to humans. Thus, apes not only perceive and understand things in the immediate here and now but they also recall things

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Fig. 1. Chimpanzees in a social group.

they have perceived in the past and anticipate or imagine things that might happen in the future. For example, in a recent study, some great apes used a tool to retrieve food, and when the food was gone they dropped the tool and left. Later, when they returned, more food was there but the necessary tool was not. After only a few repetitions of this procedure, the apes learned to take the tool with them after using it, in anticipation of the next trial when they would need it again (Mulcahy & Call, 2006).

Great apes also can make inferences about what one perceived state or event implies about another. For example, in another experiment, great apes were faced with two cups, and they knew that only one of them contained food. They then watched as a human shook one. Not only were they able to infer which one had food when they heard it in there, they were also able to infer which one had food (i.e., the other one) when the shaken cup made no sound. This is a kind of reasoning by exclusion (analogous to disjunctive syllogism in formal logic): (a) the food is in one of the cups; (b) it is not in this one (inferred from lack of sound—causal reasoning); (c) so then it must be in the other one. The apes thus used their knowledge and reasoning to imagine the food in the correct cup (Call, 2004).

Apes also can reason about the decision making of other individuals. For instance, in a recent study, human-raised chimpanzees observed a human successfully solving a problem in a particular way. The chimpanzees then either followed that way or not depending on whether their particular circumstances—that is, the obstacles to solving the problem—were the same or different as those that had faced the human demonstrator. They seemingly reasoned about why the human had chosen the behavioral means she had (Buttelmann, Carpenter, Call, & Tomasello, 2007).

Differences in Ape and Human Cognition

Since humans have brains three times larger than other great apes—and share so many basic cognitive skills with them—it would be natural to assume that humans are just more cognitively sophisticated than apes in a general way. But this is not the case; the situation is much more interesting than that.

An overall comparison

In a recent study, Herrmann, Call, Hernández-Lloreda, Hare, and Tomasello (2007) gave an extensive battery of cognitive tasks to large numbers of chimpanzees, orangutans, and 2-year-old human children. The tasks assessed all kinds of cognitive skills for dealing with both the physical and the social world. If what differentiates humans from their nearest primate relatives is simply a greater degree of general intelligence—better skills of perceptual discrimination, larger working memories, more inferencing skills, and so forth—then the children should have differed from the apes uniformly across all the different kinds of tasks. But that was not the case. The finding was that the children were very similar to the apes in their cognitive skills for dealing with space, quantities, and causality; 2-year-olds still have their same basic great-ape skills for dealing with the physical world. But these same 2-year-old children—still preliterate, prenumerical, and preschool—showed much more sophisticated cognitive skills for dealing with the social world in terms of intention-reading, social learning, and communication.

So early in ontogeny human infants show some quantitative advantages over apes in social-cognitive skills that they do not show in other cognitive domains. The proposal is that the children's special social-cognitive skills represent the dawning of a special kind of cultural intelligence evolved for participating in a cultural group. Participating in a cultural group will then enhance all of children's cognitive skills across the board, including those for dealing with the physical world—as children, for example, imitate others' tool use, acquire a language and all its conceptual categories, learn mathematical symbols and operations via instruction, and so forth. Children's special skills of social cognition thus bootstrap their skills of physical cognition by enabling them to collaborate with, communicate with, and learn from others in the cultural group.

Evolutionarily, the key difference is that humans have evolved not only social-cognitive skills geared toward competition, but also social-cognitive skills and motivations geared toward complex forms of cooperation—what we call skills and motivations for shared intentionality (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Most important are skills and motivations for shared intentionality in children's (a) collaboration and communication and (b) cultural learning and transmission.

Collaboration and communication

Virtually all of humans' highest cognitive achievements are not the work of individuals acting alone but rather of individuals collaborating in groups. Other great apes, especially chimpanzees, coordinate their actions with others in a number of complex ways—for example, in capturing small animals and in coalitions and alliances in intragroup conflicts (Muller & Mitani, 2005). But humans collaborate and communicate with one another in especially complex ways that go beyond simple coordination, ending up with such things as complex social institutions structured by joint goals, division of labor, and communicative symbols.

The ability to collaborate and communicate with others in sophisticated, species-unique ways is apparent even in prelinguistic human infants (see Fig. 2). In a recent comparative study, human 1-year-olds and juvenile chimpanzees each engaged in a collaborative task with a human adult. When the adult stopped participating, the chimpanzees simply tried to solve the task alone. The human children, in contrast, employed various forms of communication to try to reengage the adult into the task. The children seemed to understand that the two of them had committed themselves to doing this together and it simply would not do if the adult was shirking her duty. The collaboration was structured by joint goals and joint commitments to one another (Warneken, Chen, & Tomasello, 2006). It is not difficult to see in these simple activities the roots of the kind of collaborative commitments and activities that structure human social institutions, from governments to religions.

And the way humans communicate is fundamentally cooperative as well. Humans do not just try to get others to do what they want them to—which is what most animal communication (and much human communication) is about—but they also communicate simply to inform others of things helpfully and to share emotions and attitudes with them freely. Human infants communicate in this cooperative way even before they acquire language, especially with the pointing gesture (Tomasello, Carpenter, & Lizskowski, 2007). Human languages, as the pinnacles of human communication, rely on these cooperative motives as well, but they are also constituted by fundamentally cooperative communicative devices—known as linguistic conventions (or symbols)—whose meanings derive from a kind of cooperative agreement that we will all use them in the same way (Tomasello, 2008).

Both collaborative activities with shared goals and cooperative communication using shared symbols are structured by joint attention. This means that as children work together with others or communicate with them, they have a mutual awareness that this is what they are doing: We are both committed to this joint goal; or, we are both focused on this same object together. This creates the possibility of culturally constituted entities that exist because, and only because, everyone in the group believes and acts *as if* they do—for example, such things as marriage and money and presidents (Searle, 1995).

Cultural learning and transmission

All great apes, especially chimpanzees and orangutans, transmit some behaviors and information across generations culturally (Whiten & van Schaik, 2007). But the human way of living depends fundamentally and totally on cultural learning and transmission. In particular, the human way of living depends on processes of cultural evolution in which material and symbolic artifacts and social practices accumulate modifications over time (ratchet up in complexity), such that they have a "history" within the group upon which others can always build (Tomasello, 1999).

Much empirical research on social learning and imitation has shown that young children understand and reproduce, to

Fig. 2. Collaboration in young children.

a greater extent than other apes, not just the environmental result of others' actions but also the behavioral and cognitive processes used to produce that result (Whiten, 2005). In addition, other important aspects of cultural learning in humans derive from their special cooperative skills and motivations, and these add to the power of the human cultural ratchet as well. Specifically, adults teach children things intentionally—whereas teaching is not an important dimension in the lives of other great apes, if it exists at all—and teaching is a form of altruistic cooperation (free donation of information). Human children are especially attuned to adults teaching them things (Gergely & Csibra, 2006), and they trust adult instruction implicitly based on their cooperative motives. Indeed, when adults teach them things, children trust this so much they often jump to normative conclusions. Thus, they learn not just that this is how the adult did it, but that this is how it is done—this is how we in this group do it, how it *ought* to be done. For example, in a recent study, 3-year-old children who witnessed a puppet playing a game in a manner discrepant with the way they had been taught objected strenuously: The puppet was not doing it "right" (Rakoczy, Warneken, & Tomasello, 2008). Such normative judgments derive, almost certainly, from identifying with the group in terms of how "we" do things.

And so to complement their special skills of collaborating with others in the moment, human children also come into the world ready to "collaborate," as it were, with forebears in their culture, by adopting their artifacts, symbols, skills, and practices via imitation and instructed learning. Their cooperative identification with the group leads them to learn not just that this is a useful way to do things to meet individual goals, but it is the "right" way to do things, at least for members of this group. This almost moral dimension makes human cultural learning especially powerful in comparison to that of their closest primate relatives.

The Coevolution of Human Culture and Cognition

As compared with their nearest great-ape relatives, humans occupy an incredibly wide range of environmental niches

covering almost the entire planet. To deal with everything from the Arctic to the tropics, humans as a species have evolved a highly flexible suite of cognitive skills. But these are not individual cognitive skills that enable individuals to survive alone in the tundra or rain forest, but rather they are social-cognitive skills that enable them to develop, in concert with others in their cultural groups, creative ways of coping with whatever challenges may arise. Humans have not only skills of individual intentional action and cognition but also skills and motivations for sharing intentions and cognition with others.

What most clearly distinguishes human cognition from that of other primates, therefore, is their adaptations for functioning in cultural groups. Groups of individuals cooperate together to create artifacts and practices that accumulate improvements (rachet up in complexity) over time, thus creating ever-new cognitive niches (Tomasello, 1999). Children must be equipped to participate in this process during their development by means of species-unique cognitive skills for collaboration, communication, and cultural learning. Humans are thus characterized to an inordinate degree by what has been called niche construction and gene–culture coevolution (Richerson & Boyd, 2005), as the species has evolved cognitive skills and motivations enabling them to function effectively in any one of many different self-built cultural worlds.

Some important questions for future research include the following:

- How precisely do children's skills of collaboration and imitative learning differ from those of other great apes?
- Do great apes teach? Is human teaching part and parcel of their more cooperative way of communicating, or something different?
- What are the differences in motivation and emotion that contribute to humans' special cooperative tendencies and skills?
- How do humans' skills of cultural creation and cultural learning differ across cultures—especially those that emerge early in ontogeny?

Recommended Reading

Call, J., & Tomasello, M. (2008). (See References). A concise review of research on chimpanzee social cognition (theory of mind) over the past 30 years.

Herrmann, E., Call, J., Hernández-Lloreda, M., Hare, B., & Tomasello, M. (2007). (See References). Results of the administration of a very large cognitive test battery to large numbers of chimpanzees, orangutans, and 2-year-old human children.

Richerson, P.J., & Boyd, R. (2005). (See References). A comprehensive description of research and theory on the nature of human culture in evolutionary context.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). (See References). A theoretical framework for thinking about how skills and motivations of shared intentionality manifest themselves during human ontogeny.

Tomasello, M. (2008). (See References). A theoretical account of how cooperative communication, including conventional languages, emerged in human evolution.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

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