relevant events in the world needs to be investigated more systematically, but it remains a possibility. Whether primates deal with ignorant receivers in different ways compared to knowledgeable ones is equally unclear, although they are able to make such discriminations in other contexts.

In sum, according to current evidence, nonhuman primates share many of the key features of human communication although humans appear to be unique in their ability to control their vocal tracts and in their motivation to base their communicative behavior based on shared knowledge and intentions. Primates may or may not have the required social cognition. If they do, they do not make regular use of it. Why only humans are socially motivated to inform each other about their experiences thus lies at the heart of the human–primate divide. One popular idea is that humans are more cooperatively motivated than other primate species, as for example reflected in high degrees of mutual tolerance or willingness to help strangers. Whether this cooperative propensity has evolved in the context of childcare, foraging, intergroup conflict, or elsewhere is unresolved.

Cross-References

- ► Comparative Psychology and Ethology
- ► Concept Learning
- ► Imitative Learning in Humans and Animals
- ► Intelligent Communication in Animals
- ► Social Cognition in Animals

References

Call, J., & Tomasello, M. (2007). *The gestural communication of apes and monkeys*. London: Taylor & Francis Lea.

Seyfarth, R. M., & Cheney, D. L. (2003). Signalers and receivers in animal communication. *Annual Review of Psychology, 54*, 145–173.

Tomasello, M., & Call, J. (1997). *Primate cognition*. New York: Oxford University Press.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science, 10*, 121–125.

Zuberbühler, K. (2008). Referentiality and concepts in animal cognition. In L. R. Squire (Ed.), *Encyclopedia of Neuroscience*. Oxford: Academic Press.

Zuberbühler, K., Ouattara, K., Bitty, A., Lemasson, A., & Noë, R. (2009). The primate roots of human language: Primate vocal behaviour and cognition in the wild. In F. d'Errico & J.-M. Hombert (Eds.), *Becoming eloquent: Advances in the emergence of language, human cognition, and modern cultures* (pp. 235–266). Amsterdam: John Benjamins.

Cognitive Aspects of Prosocial Behavior in Nonhuman Primates

Katherine A. Cronin
Comparative Cognitive Anthropology Group, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

Synonyms

Donation; Helpful Behavior

Definition

Prosocial behavior is any behavior performed by one individual that results in a benefit for another individual. *Prosocial motivations, prosocial preferences*, or *other-regarding preferences* refer to the psychological predisposition to behave in the best interest of another individual. A behavior need not be costly to the actor to be considered prosocial, thus the concept is distinct from *altruistic behavior* which requires that the actor incurs some cost when providing a benefit to another.

Theoretical Background

It is generally agreed that humans are a prosocial species; for example, we provide assistance to fellow humans by donating to charities, donating blood to strangers, and voting. A renewed interest in nonhuman primate prosocial behavior has emerged among comparative psychologists in the last decade. Currently, three hypotheses predominate the literature on prosocial behavior in nonhuman primates:

1. Prosocial behavior is uniquely human.
2. Prosocial behavior emerges from a cooperative breeding social system (a social system in which nonbreeding individuals help to care for infants).
3. Prosocial behavior is a general predisposition of nonhuman primates that reflects the early origins of human empathy.

Important Scientific Research and Open Questions

Recent investigations of prosocial behavior in nonhuman primates have often employed the *prosocial*

choice task. In the prosocial choice task, subjects are presented with a choice between a prosocial option that provides a single reward (often food) to himself or herself and to the recipient (referred to as the "1/1" option to denote that one reward is received by the actor and one reward is received by the recipient) and another option which provides a reward for the actor only (the "1/0" option). The effort required of the actor is the same for both choices; the choices differ only by whether or not the recipient also receives a reward. The proportion of trials on which actors choose the prosocial option is compared with a control condition in which no recipient is present (a nonsocial control). Evidence of prosocial behavior is assumed if the actor chooses the prosocial option more often when a recipient is present to receive the reward than when there is no recipient present.

The resurgence of interest in nonhuman primate prosociality was sparked by findings indicating that chimpanzees did not demonstrate prosocial behavior on this task. In fact, chimpanzees across multiple captive populations chose randomly between the two choices, showing no increase in the prosocial response when a partner was present compared to absent (e.g., Silk et al. 2005). These findings provided initial support for the hypothesis that prosocial preferences are uniquely human and emerged in the human lineage after our ancestors diverged from the other great apes, or within the last six million years of evolution (hypothesis 1, above).

Positive results from additional primate species soon followed that suggested prosocial preferences are not uniquely human and may in fact be a characteristic shared by humans and cooperative breeding species (hypothesis 2, above). Across primate species, breeding systems can be arranged along a continuum defined by which individuals bear responsibility for offspring care. At one end of the continuum are independent breeders. In independently breeding species, care is provided nearly exclusively by the mother. This is the breeding system of most primate species, including chimpanzees. However, at the other end of the continuum are cooperative breeders in which many group members are actively involved in infant care, including the father, siblings, aunts, uncles and sometimes unrelated individuals. Helpful behaviors by the nonbreeding individuals are essential to the survival of the offspring. Some propose that ancestral hominids were cooperative breeders, that modern human minds are adapted for a cooperatively breeding environment, and that one of the ways the cooperative breeding environment influenced our psychology was to predispose individuals to behave prosocially (e.g., Burkart et al. 2009).

Therefore, the cooperative breeding hypothesis predicts that prosocial preferences would be expressed not by our closest living primate relatives the chimpanzees, but instead by cooperative breeders. In the primate order, cooperative breeding occurs in the taxonomic family Callithrichidae, the marmosets, and tamarins. Empirical support for the cooperative breeding hypothesis was generated by presenting marmosets and tamarins with the same prosocial choice task that was utilized with chimpanzees. Unlike chimpanzees, marmosets and tamarins demonstrated prosocial preferences (e.g., Burkart et al. 2009; Cronin et al. 2010). These findings support the hypothesis that there are psychological adaptations associated with cooperative breeding that positively influence prosocial preferences.

However, positive results from the prosocial choice task are emerging from primate species that are not cooperative breeders, indicating that cooperative breeding is not necessary for prosocial behavior (e.g., Massen et al. 2010). Furthermore, under some experimental conditions, cooperative breeders do not show prosocial preferences on the prosocial choice task (Cronin et al. 2009). These mixed results suggest that the expression of prosocial behavior will not be explained by social systems or evolutionary history alone and that prosocial behavior is dependent upon a myriad of ultimate and proximate influences. Along these lines, de Waal and colleagues have proposed that the proximate mechanism that elicits prosocial behavior among nonhuman primate species is empathy, or the sharing of an emotional state with another (hypothesis 3, above). de Waal argues that some basic form of empathy is present throughout the primate order. The likelihood of expressing prosocial behavior among primates therefore depends on the ability to match the emotional state of the potential recipient, an ability that will be affected by social factors such as the degree of social closeness with that individual (de Waal and Suchak 2010).

The proximate, psychological mechanisms that underlie prosocial behavior in nonhuman primates is a rich area for future research. For example, some results point to differences in the intrinsic reward experienced when providing benefits to another individual that may differentially reinforce prosocial behavior across species (e.g., Cronin et al. 2010). Other results suggest that the ability to inhibit one's own motivation for the reward is necessary for prosocial behavior to be expressed. Additionally, perspective-taking and theory of mind abilities may impact the execution of prosocial behaviors since realization of the needs of others may in some circumstances rely on these cognitive capacities. However, the influence of psychological mechanisms on prosocial behavior in nonhuman primates has received little attention. Research on the cognitive influences on prosocial behavior promises to provide some much-needed answers to the question of how and when prosocial behavior emerges among nonhuman primates.

Cross-References

- ► Intelligent Communication in Animals
- ► Social Cognition in Animals
- ► Social Learning in Animals

References

Burkart, J. M., Hrdy, S. B., & van Schaik, C. P. (2009). Cooperative breeding and human cognitive evolution. *Evolutionary Anthropology, 18*(5), 175–186.

Cronin, K. A., Schroeder, K. K. E., Rothwell, E. S., Silk, J. B., & Snowdon, C. T. (2009). Cooperatively breeding cottontop tamarins (*Saguinus oedipus*) do not donate rewards to their long-term mates. *Journal of Comparative Psychology, 123*(3), 231–241.

Cronin, K. A., Schroeder, K. K. E., & Snowdon, C. T. (2010). Prosocial behaviour emerges independent of reciprocity in cottontop tamarins. *Proceedings of the Royal Society of London Series B-Biological Sciences, 277*(1701), 3845–3851.

de Waal, F. B. M., & Suchak, M. (2010). Prosocial primates: Selfish and unselfish motivations. *Philosophical Transactions of the Royal Society Series B-Biological Sciences, 365*(1553), 2711–2722.

Massen, J. M., van den Berg, L. M., Spruijt, B. M., & Sterck, E. H. M. (2010). Generous leaders and selfish underdogs: Pro-sociality in despotic macaques. *PLoS ONE, 5*(3), e9734.

Silk, J. B., Brosnan, S. F., Vonk, J., Henrich, J., Povinelli, D. J., Richardson, A. S., Lambeth, S. P., Mascaro, J., & Schapiro, S. J. (2005). Chimpanzees are indifferent to the welfare of unrelated group members. *Nature, 437*, 1357–1359.

Cognitive Automatisms and Routinized Learning

Nathalie Lazaric

CNRS – GREDEG, University of Nice Sophia Antipolis, Valbonne, Sophia Antipolis, France

Synonyms

Automatic encoding; Automatic process; Cognitive lock-in

Definition

The question of cognitive automatisms was first addressed from the perspective of individuals' attention and their limited capacities and bounded rationality. Shiffrin and Schneider (1977) consider two types of information processing. The controlled process is performed more slowly because it is maintained in working memory, which requires conscious effort and sustained attention. The automatic process, on the contrary, does not require attention in order to be performed.

Theoretical Background

Shiffrin and Schneider's (1977) research has influenced research in cognitive science by suggesting that visual automation is different from motor-sensory automation. In the context of motor-skill development, automation is comparable to a flexible pattern subject to multiple parameters; it is not necessarily a rigid process as some might naively imagine. Shiffrin and Schneider (1977) distinguish several levels of automation: (a) a highly automatic type of information processing that does not require any particular attention; (b) a partly automatic process which attention can influence; and (c) automatic information processing that typically requires attention.

These studies concur with and complement the work of Anderson (1983) by putting in perspective the automatic process implemented by individuals. In the so-called proceduralization phase, knowledge is directly incorporated into procedures for the execution of skills, which makes it possible to minimize demands on working memory, but this can also lead to errors if the compilation phase is too short. In other words, the