hydrocarbon biofuels from algae in 5 to 10 years (*22*).

Hydrocarbons derived from biomass are attractive because of their high energy density and compatibility with existing energy infrastructure. If recent technological innovations result in competitive production costs, hydrocarbons rather than ethanol will likely be the dominant biofuel.

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BEHAVIOR

Monkeys Like Mimics

Josep Call and Malinda Carpenter

Human adults routinely engage in unconscious (automatic) bodily mimicry of each other, and this has many positive social consequences. When others mimic us, we like them more, empathize with them more, and are more helpful and generous toward them (*1*). On page 1080 in this issue, Paukner *et al.* (*2*) show that these social consequences of mimicry may have deeper evolutionary roots than previously thought.

Adding to previous findings that apes (*3*, *4*) and macaque monkeys (*5*) recognize when they are being imitated, Paukner *et al.* demonstrate that imitation recognition has consequences for nonhuman primates in terms of their later affiliative behavior toward the imitator. They found that capuchin monkeys are more likely to sit closer to and exchange tokens with a human who imitated their actions than one who did not.

Most previous experimental work on imitation in nonhuman primates has focused on the instrumental function of imitation: learning new behaviors, typically to extract food from an unfamiliar apparatus. By contrast, Paukner *et al.* look at imitation in nonhuman primates from a more social and interpersonal perspective. In humans, imitation is not only a way of acquiring new behaviors, but also is a way of connecting with others and aligning

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Imitation. Monkeying shows the acquisition of new behaviors and facilitates connections with others.

oneself with them—of communicating one's likeness and affinity to others (*6*). This social function of imitation is apparent from a very early age, when human children copy others closely (see the figure), even in problem solving tasks when copying the particular actions the demonstrator used often is not necessary to achieve the instrumental goal (*7*). Both adults and children copy others more often when social goals are important (*8*, *9*).

However, as Paukner *et al.* acknowledge, whereas the capacity to recognize imitation now appears to be widespread among primates, imitation itself is thought to be relatively rare in monkeys and apes, and certainly far less prevalent than in humans (*10*). It is thus unclear whether monkeys actually copy each other enough in their natural social

Human and nonhuman primates recognize when they are being imitated. Is there a social advantage to that?

groups for imitation recognition to serve the affiliative functions Paukner *et al.* postulate. Nonhuman primates do show contagious yawning (*11*) and some facial mimicry (*12*), but it is unknown how common and wide-ranging automatic bodily mimicry and imitation are for social functions in the natural social lives of nonhuman primates. Traditionally, researchers have used the distribution of grooming among individuals to assess affiliative networks in apes' and monkeys' social groups. Although it is conceivable that "mimicry networks" could accomplish a similar function, it is also possible that mimicry does not indicate affiliation per se; rather, it could indicate a different type of social information such as dominance. Individuals who copy others might be perceived as subordinate and therefore safer to approach. This could explain why monkeys in the Paukner *et al.* study approached the imitating partner (or avoided the nonimitating partner) to exchange tokens. Future studies will be needed to ascertain precisely what type of social information nonhuman animals extract from social mimicry.

If nonhuman primates do copy others' behaviors for social functions, this raises intriguing questions. Can monkeys mimic tactically, as humans do (*8*), to ingratiate themselves with others? This could be a powerful tool for developing, maintaining, and assessing social bonds with others. And does being mimicked have other, more actively prosocial consequences, as it does in humans (*13*)? For

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example, nonhuman primates who have been mimicked may help or share resources with others more often than those who have not been mimicked.

The finding of a link between imitation recognition and affiliative behavior in nonhuman primates highlights the need for more research into the social functions of imitation in nonhumans. We also need to explain why human imitation goes so far beyond automatic mimicry, in our "over-imitation" as children (*14*), our conformity to the majority's way of doing things, our learning of actions conventionally and normatively (*15*), and our faithful transmission of such an extensive variety of cultural artifacts, rituals, and customs. An enhanced motivation to be like others may be what has boosted our imitation to such high levels.

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PHYSIOLOGY

How Much Sleep Do We Need?

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Sufficient sleep is necessary for optimal daytime performance and well-being, yet there is a large difference in how much sleep people need, ranging from less than 6 to more than 9 hours. People at all points along this range exhibit no measure is directly and predictably correlated with the duration of preceding waking, it only marginally predicts sleep duration, which indicates that sleep loss is primarily recovered by increasing sleep intensity and not necessarily by sleep duration.

Mutations that affect sleep duration are a starting point for understanding sleep regulation and function.

activates a negative feedback loop involving expression of the *Cryptochrome* (*Cry1* and *-2*) and *Period* (*Per1* and *-2*) genes (*4*). Although DEC1 and -2 were also proposed to act as negative regulators of the circadian clock (*5*), their precise role is still unclear. For