Animal cognition: Adaptive cooperation strategies in marmoset monkeys

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https://doi.org/10.1016/j.cub.2025.07.078

A recent study found that marmoset monkeys learned to coordinate their actions to successfully complete a cooperative pulling task. Notably, the marmosets flexibly adapted their cooperative behaviors based on social context, demonstrating that cognitively guided cooperation is more widespread and dynamic in nonhuman primates than previously recognized.

The cooperative pull task has been a staple in animal cognition research for decades, valued for its elegant simplicity and cross-species adaptability. In the classic version of the task, a piece of food is placed on a tray equipped with ropes extending from either side. To obtain the reward, two animals must simultaneously pull the ropes; if only one animal pulls, the rope slips away and the tray remains stationary. This design creatively captures the essence of mutual cooperation, as both individuals must act together, at the right time, to succeed. Because the logic of the task is straightforward and ecologically intuitive, it has been successfully adapted for a diverse array of species — ranging from primates and elephants to ravens, parrots, and otters[1–8] — generating a rich comparative dataset on the evolution and diversity of cooperation and social coordination across the animal kingdom. In a study reported in this issue of *Current Biology*, Meisner, Shi *et al.*[9] implemented a novel, automated version of this task with marmoset monkeys that enabled a far deeper assessment of cooperative behaviors. They reveal that pairs of marmosets flexibly adapt their cooperation strategies based on the specific nuances of the social context, including relative rank, relatedness and sex of the participants. This study not only brings this classic paradigm into the modern age but illustrates that the dynamics of cooperative behaviors in marmosets are far richer than thought previously.

Despite its many strengths, the traditional cooperative pull task is not without its limitations. Most notably, its analog nature constrains both the number of trials that can be conducted within a session and the kinds of experimental manipulations that can be performed. Each trial often requires manual reset, and coordination is typically observed in a spatially open arena that complicates precise measurement of individual behaviors. Moreover, the variable conditions inherent in the setup — such as spacing, rope tension, and inadvertent experimenter cues — introduce a level of noise that makes it difficult to systematically isolate the factors that drive cooperative success or failure. These challenges have ultimately limited the task's utility in addressing mechanistic questions, particularly those related to neural underpinnings. While the task can reveal *that* cooperation occurs, it is less suited to uncovering *how* animals generate, monitor, and adapt their cooperative strategies in real time.

A game-changing development for the field arrived with the introduction of an automated version of the cooperative task by Meisner *et al.*[10]. In this paradigm, pairs of marmoset monkeys — small, cooperatively breeding New World primates — are situated in adjacent test cages and presented with levers they must pull simultaneously to obtain a reward. This task retains the central demand of temporal coordination but removes many of the confounding variables of the classic setup. More importantly, it dramatically increases trial throughput and enables precise quantification of each animal's behavior on a frame-by-frame basis, including real-time tracking of eye movements and gaze patterns. The design makes possible what was previously out of reach: a high-resolution analysis of naturally occurring social cooperation dynamics in an experimentally controlled, repeatable setting.

While originally developed for marmosets, this automated paradigm has broad potential for comparative studies. It is species-agnostic in principle, amenable to adaptation for other primates, mammals, and avian species. It represents a new standard for animal cognition experiments that seek to bridge ethological relevance with experimental rigor. By preserving natural social behavior while enabling controlled manipulations, the paradigm opens the door to probe the perceptual, cognitive, and neural mechanisms underlying cooperation at an unprecedented level of detail.

In the new study, Meisner, Shi *et al.*[9] leveraged this innovative paradigm to investigate how marmoset dyads flexibly coordinate their behavior across multiple trials and social contexts. The findings are remarkable — not only for the insights they provide into marmoset social cognition, but for what they reveal about the general nature of cooperation. The authors found that marmosets do not rely on a single strategy to succeed: instead, they deploy a diverse repertoire of coordination modes, including rhythmic synchronization ('pull-in-rhythm') and visually guided timing based on real-time monitoring of a partner's behavior ('gaze-and-pull'). These strategies are not fixed actions of particular individuals or dyads, but rather marmosets switch between them fluidly depending on context.

Interestingly, the choice of strategy varies with social factors including dominance rank, kinship, sex, and the specific identity of the partner on a given day. Dominant individuals were more likely to use gaze monitoring, actively tracking their partner's readiness before initiating action. Subordinates, by contrast, more often relied on establishing a consistent rhythmic tempo that dominant individuals could then follow. This behavioral asymmetry suggests that individuals assume different functional roles depending on their relative position in the social hierarchy — a finding with clear parallels in human cooperative behavior.

The flexibility shown by these animals is especially noteworthy given the traditional view that complex cooperative planning is a hallmark of great apes, such as chimpanzees and humans. Marmosets, despite their phylogenetic distance from apes, from which their lineage diverged ~35 million years ago, appear capable of dynamic strategy adjustment, sensitivity to social variables, and joint action planning. This raises important questions about the evolutionary pathways through which cooperative behavior emerges. One possibility is that marmosets' cooperative breeding system has selected for specialized cognitive adaptations that support high levels of prosociality and coordination. As members of family groups where multiple individuals help care for offspring, marmosets may have evolved enhanced social monitoring skills, partner modeling abilities, and mechanisms for shared intentionality that resemble, in some respects, those seen in apes and humans.

From a methodological perspective, the Meisner, Shi *et al.*[9] study provides a powerful demonstration of how naturalistic yet controlled paradigms can reveal latent cognitive capacities that traditional setups may obscure. The ability to monitor gaze behavior, track reaction times, and manipulate task parameters across many trials allows researchers to move beyond anecdotal descriptions toward quantitative models of cooperative dynamics. Importantly, the automated design enables the types of perturbation experiments — such as delays, occlusions, or sensory manipulations — that are necessary to identify causal mechanisms.

The broader implications for neuroscience are also profound. Marmosets are rapidly becoming a preferred primate model in systems neuroscience due to their small size, fast reproduction, and amenability to naturalistic behavior paradigms and cutting-edge neural recording approaches. Yet the success of neuroscience in this species will ultimately depend on the availability of behavioral paradigms that engage their natural cognitive strengths. This study exemplifies how a well-designed task can do just that — leveraging species-typical behaviors to explore deep questions about the brain's role in social interactions. It offers a template for how we might study the neural basis of cooperation not in abstract terms, but in the ecologically valid context in which it evolved[11].

Meisner, Shi *et al.*[9] have delivered a landmark contribution to the study of animal cooperation. Their work shifts the field away from more traditional conceptions of joint action and toward a dynamic, context-sensitive view of coordination as an emergent property of socially interacting individuals. By showing that monkeys can flexibly deploy multiple strategies depending on social and environmental conditions, the study challenges long-standing assumptions about the cognitive foundations necessary for cooperation. It also provides a powerful new tool kit for future investigations — both behavioral and neurobiological — into the mechanisms that allow social animals to act in concert.

DECLARATION OF INTERESTS

The author declares no competing interests.

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