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Parenting Behaviour: Babbling Bird Teachers?

One of humankind's most distinctive characteristics is our extended and complex period of child dependency. New research on a noisy African bird may help to shed light on how our unusual parenting behavior evolved.

Lisa G. Rapaport

We humans are extraordinarily solicitous parents. This is not to say that intensive infant-care duties, like feeding and keeping watch over baby, are so remarkable. Other primates do the same for their infants, and many other vertebrate species do, too. What makes us stand out as parents are both the duration (relative to lifespan) and complexity of our caretaking behavior. New research from an unexpected source, reported in this issue of *Current Biology* [1], may help to shed light on how our unusual parenting behavior evolved.

Unlike most other animals, human parents continue to invest in their offspring well into adulthood. For example, in rural Ethiopia, mothers regularly visit their married daughters' households, helping with heavy domestic chores, and in so doing increase the survival prospects of their grandchildren [2]. In industrialized nations, parents often invest extensively in their children's education to help them succeed in a competitive environment. Many of the readers of this article undoubtedly know families who have even welcomed back into the parental nest offspring who have finished college but just have not yet been able to land that lucrative job.

Human parental care is complex because it is characterized by changes in the type of care offered as the child matures; emphasis shifts during development from providing for nutritional and other basic physical needs to training and encouragement. This lengthy period of dependency is integral to who we are as a species. Anthropologists have argued that in subsidizing the diets of young group members, provisioning supported a prolonged learning period, and was the lynchpin that permitted our ancestors to specialize on increasingly varied and difficult-to-acquire resources, and the technological advances used to exploit them [3].

Given such importance to the human life history strategy, one might expect to find an extended period of provisioning as well as adult instruction or encouragement of offspring learning among our primate relatives, at least in nascent form. But provisioning of weaned young generally is infrequent and active support of skill development is virtually nonexistent. When a human child takes on a new skill, his or her caregiver often plays a facilitating role. Among nonhuman primates, in contrast, learning is a much more exclusively self-motivated proposition [4]. A young wild chimpanzee must learn to recognize and process hundreds of different kinds of food by paying close attention to what the mother and other adults eat. A mother usually tolerates her juvenile feeding in the same area and taking an occasional scrap of food, but even complex foraging techniques such as termite-fishing (in which a tool, designed from nearby vegetation, is inserted into a mound to extract termites) and other types of tool use are learned without active guidance from adults [5,6].

In this issue, Radford and Ridley [1] report how wild adult pied babblers modify their caretaking behavior in a way that may favor learning by juveniles. Pied babblers (*Turdoides bicolor*) are medium-sized passerine birds of southern Africa, noted for their steady chattering contact calls — hence the name. They inhabit scrubby acacia woodlands and savanna, and spend much of their time foraging on the ground for invertebrates [7]. Groups typically consist of one breeding pair and several non-reproductive adults, all of whom help to care for the group's altricial young, a type of social system called cooperative breeding [8,9]. The study's most remarkable observation is not that pied babblers provision their group's young: all birds who have helpless, relatively immobile hatchlings must provision their young. Nor is it that adults preferentially allow fledglings to share their foraging sites with them: tolerance for immatures while foraging is known in a variety of bird species [10–12]. The striking finding is that adults appear to take an active and variable role in the development of their fledglings' foraging abilities.

Radford and Ridley [1] observed that, a few days before young pied babblers fledge, adults begin to emit a soft 'purr' vocalization when they bring food to the nest. Upon fledging, the young follow foraging adults and solicit food from them (Figure 1), while adults, for their part, continue to use the purr vocalization during provisioning interactions. It is at this point that adults begin to purr-call from time to time in a new context: while foraging. Using playbacks of calls, experiments with supplemental

Figure 1. An adult pied babbler, with well-defined black and white coloration, offers food to a conspicuously begging fledgling. (Photo by A.N. Radford.)

food, and observations of unmanipulated behavior, the authors found that adults purr-called most frequently when the group contained fledglings, that fledglings approached in response to calls more often than adults (and when adults did approach, they were often chased away by the caller), and that food patches were depleted more rapidly when a fledgling joined the caller to feed.

The babblers' age-sensitive caretaking behavior meets three of the four objective criteria proposed by Caro and Hauser [13] to qualify as teaching: the adults modify their behavior in the presence of inexperienced individuals; calling is costly to adults in terms of time spent feeding in a patch; and by recruiting fledglings to productive foraging patches, the adults' behavior encourages them to gain age-appropriate experience. Because Radford and Ridley [1] do not specifically address the issue of teaching, they did not attempt to determine whether babblers meet the remaining criterion, that inexperienced individuals acquire information or skill more quickly as a result of such guidance. Nonetheless, the babbler's recruitment calling may even qualify as teaching under a more stringent definition: that the information transferred facilitates learning of skills and strategies, rather than simple facts such as the locations of foraging sites [14]. With the exception of termite nests, which are relatively permanent fixtures in the landscape, babbler foraging patches are ephemeral and so any information value to fledglings may have more to do with what a good foraging patch should look like rather than a specific foraging site's location.

Radford and Ridley's article follows on the heels of a report on teaching in meerkats [15]. These cooperatively breeding African mongooses encourage their pups to develop prey-handling skills, particularly with regard to dangerous prey like scorpions. As the pups grow, adults increasingly refrain from killing the prey they give to them and with such experience pups learn effective prey-dispatch methods, thus satisfying Caro and Hauser's [13] fourth criterion. The meerkat results [15] are consistent with previous, largely anecdotal evidence suggesting that routine teaching is most pervasive among predators, such as raptors, felids, and orcas, that train their young to hunt [13,16]. It has been widely accepted that the selective force favoring active parental guidance of skill development is a dietary niche, like reliance on large prey, that is both challenging and hazardous. Radford and Ridley's [1] research calls this supposition into question. Pied babblers do occasionally eat scorpions, lizards and small snakes, but adults tend to recruit fledglings to feed on innocuous insects [1,7].

The question is whether risky foraging strategies or some other aspect of the babblers' biology has favored their unusual sequence of caretaking behavior. One clue brings us back to the primates. The only other species in which recruitment calling to juveniles has been documented, besides felids, is a diminutive South American monkey, the golden lion tamarin [17,18]. In the monkeys' case, the calls encourage juveniles to search for hidden prey. Like pied babblers and meerkats, tamarins provision their young — and are cooperative breeders. Historically, we humans, too, have been cooperative breeders, in that mothers have consistently relied on relatives for childcare assistance [2,19]. Could it be that sharing responsibilities among multiple group members somehow favors prolonged and complex caretaking behavior, and even teaching? If so, we may have a lot to learn from other animals that cooperate to care for their young. Radford and Ridley's [1] research should stimulate a wide-ranging search for answers.

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Chromosome Segregation: Correcting Improperly Attached Chromosomes

Two new studies show that Aurora B kinase corrects improperly attached chromosomes by recruiting molecules necessary for eliminating the bad attachments and by regulating the turnover of the kinetochore fiber.

Xin Zhang and Claire E. Walczak

The proper segregation of chromosomes to the two daughter cells is an essential part of the cell cycle. Defects in this process result in aneuploidy, which can lead to genomic instability and cancer. Accurate chromosome segregation in mitosis requires that sister kinetochores on the mitotic chromosomes attach properly to microtubules emanating from opposite spindle poles, but the molecular mechanisms underlying this process are not yet understood. One key player in sensing and correcting improper kinetochore–microtubule attachments is Aurora B kinase, inhibition of which results in multiple mitotic defects, including the failure to detect or correct improper attachments. Understanding how Aurora B works requires the identification of key downstream substrates, such as the microtubule depolymerizing kinesin, MCAK, which is also involved in regulating proper kinetochore–microtubule interactions. Two papers in this issue [1,2] reveal some new hints about the mechanism by which Aurora B corrects improper attachments. These studies show that molecules such as MCAK and the Aurora B complex itself are selectively and preferentially localized to defective attachment sites, where they act to control the attachment state by regulating the dynamics of the kinetochore-fibers.

In vertebrate cells, the kinetochores are attached to the spindle poles by bundles of microtubules that form the kinetochore-fibers. Defective attachments, such as merotelic attachments in which a single kinetochore is attached to microtubules emanating from both spindle poles, are particularly damaging because they are not sensed by the spindle assembly checkpoint, but do cause lagging chromosomes during mitosis [3,4]. Luckily for cells, merotelic attachments occur frequently in early mitosis, but most are corrected before anaphase by as yet unknown mechanisms [5]. It has recently been shown that many of the merotelic attachments that persist in anaphase often get segregated to the pole with the thicker kinetochore-fiber bundle, which is presumably the correct spindle pole. But then how does Aurora B function in this process?

Cimini *et al.* [1] took advantage of a small molecule inhibitor of Aurora B, ZM44739 [6], to partially inhibit Aurora kinase and then examined the properties of the kinetochore-fibers. They found that partial inhibition of Aurora B kinase resulted in an accumulation of lagging chromosomes at anaphase, in part by increasing the fraction of microtubules that are attached to the incorrect pole. To look more closely at the microtubules within the kinetochore-fiber, they used a photoactivatable derivative of the fluorescent fusion protein GFP-tubulin to measure the dynamics of the microtubules within the kinetochore-fiber. They found that partial inhibition of Aurora B caused a dramatic stabilization of the kinetochore-fibers, but had no effect on the turnover of bulk spindle microtubules. This provides a potential explanation for why the attachments are not corrected, because the microtubules within the kinetochore-fiber are unlikely to be detaching from the kinetochore.

Interestingly, while the dynamics of the kinetochore-fiber microtubules were dramatically reduced by Aurora B inhibition, the amount of tension between the two sister kinetochores was not significantly perturbed. This