

Recess

Fish, reptiles, and even some invertebrates appear to play. But when is it play, and not something else? And why do animals do it?



Illustrations by Kaitlin Beckett

During a visit to the National Zoo in Washington, DC, biopsychologist Gordon Burghardt decided to peek in on a Nile soft-shelled turtle its keepers affectionately called “Pigface.” Pigface had been a zoo resident for more than 50 years, and Burghardt had seen him before, but this time, he noticed something a bit curious—Pigface was playing basketball.

“It was by itself,” recalls Burghardt, currently at the University of Tennessee in Knoxville, and “it had started to knock around” a basketball provided by its keepers. The year was 1994, and play had only rarely and anecdotally been reported in animals other than mammals, but he thought that might be what Pigface was doing. The 1-meter-long turtle exuberantly pushed the ball around its aquatic enclosure, swimming through the water with ease as it batted the ball in front of it with its nose. “If you saw a dog or an otter going around batting a ball, bouncing around and chasing it, and going back and forth and doing it over and over again, we’d have no problem calling it play,” he says. “And that’s what the turtle was doing.”

More recently, ethologist Jennifer Mather of the University of Lethbridge in Canada learned that two of her octopus research subjects had repeatedly blown jet streams of water at floating empty pill bottles, shooting them across the surface of their tanks at the Seattle Aquarium. “If you give an [octopus] something new, it will grab it in its arms and bring it up to its mouth, probably exploring it chemically,” she says. This would usually happen a couple of times, she adds, until it

“knew what it was, and didn’t bother anymore. But these two, it’s like they suddenly thought, ‘Maybe I can do something with this.’ ”

For Burghardt and Mather and most researchers who have witnessed such bizarre activities in reptiles, fish, and even invertebrates, it is clear that these animals engage in some form of play. But not everyone is convinced. “I personally doubt it,” says behavioral physiologist Bernd Heinrich of the University of Vermont. “I personally have never seen anything I’d call ‘play’ in turtles and wasps, both of which I’ve watched quite a bit. [To say these animals are playing], I think you really have to be stretching the idea of play.”

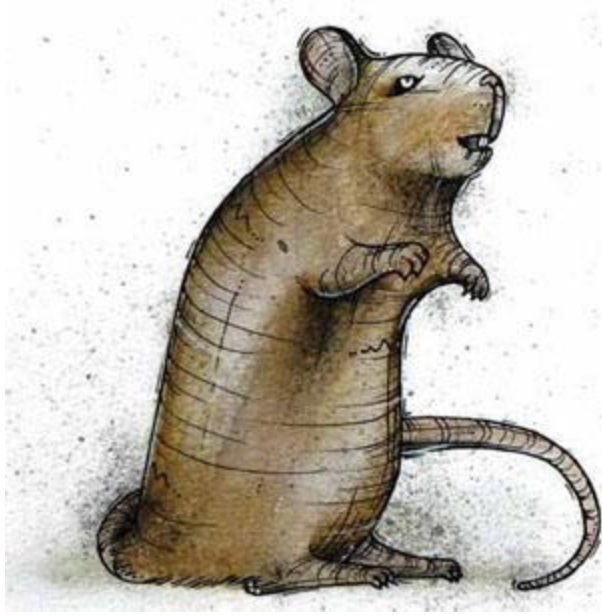
To find play outside the realm of mammals is incredibly exciting [and] quite humbling. —Kerrie Lewis, Texas State University

Part of the controversy stems from the difficulties researchers have formulating a solid working definition of what constitutes play. “You know it when you see it, but it’s kind of hard to [define],” says Kerrie Lewis of Texas State University, who studies the neuroanatomy of play in primates. For mammals that are more similar to humans, one can usually identify play behavior by simply looking for behaviors that are reminiscent of a child playing, or by equating the behavior to that seen in animals where play is obvious, such as puppies. It’s not hard to tell, for example, that when young chimpanzees chase and wrestle each other, they are just like kids at play. While such anthropomorphizing is generally verboten in biology, when defining play, it can be a “valid argument,” says behavioral biologist and psychologist Edwin van Leeuwen of the Free University of Amsterdam. With regard to play behavior, “interobserver reliability” can also serve as a useful “criterion to determine if it’s play behavior or not,” he says. “There is some value to our intuition.”

The difficulty, then, comes in observing animals so different from us that assigning human emotions is next to impossible. “When we’re looking at species more distantly related to us, we have to rely on more strict criteria,” van Leeuwen says. “We don’t have that same feeling [as we do] when we look at chimpanzees.”

In addition to the lingering uncertainty of how widespread play is, there is the fundamental—yet frustratingly enigmatic—matter of its function in animals. “It’s such a pleasure to watch, [but] no one knows why they do it,” says behavioral ecologist Lynda Sharpe of the University of Stellenbosch in South Africa. “It’s generally accepted that it’s beneficial, but we don’t know why; we don’t know what the advantages are.”

But despite this void in scientists’ understanding of the behavior, theories about why play exists abound. “Play is intriguing to me because it takes in so many other aspects of behavior. It’s a big mystery,” says Lewis. Although it may be hard to define, “when you see it, you think, ‘What is it, if it’s not play?’ They’re not feeding themselves, they’re not trying to get a mate, they’re not searching for shelter. They’re playing.”



LAUGHING RATS

For years, neuroscientist Jaak Panksepp had been watching rats play at the College of Veterinary Medicine at Washington State University, and recording some extremely high-pitched vocalizations they made as they did so. Then one morning in 1996, it hit him. Maybe, he thought, the bizarre sounds his lab rats made while they played were something akin to human laughter.

“I just walked into the lab and [said], ‘Let’s go tickle some rats,’” he recalls. Sure enough, flipping the rats on their backs and giving them a good belly tickle elicited a response that “was so wonderfully strong and powerful,” he says—the rats just couldn’t stop “laughing.”

Panksepp saw great value in studying rat laughter (technically termed ultrasonic vocalizations, or USVs). He suspected that the sound could be used as an objective measure of the animals’ positive affect, or pleasure, as it was produced most consistently during playtime, which was known to be a pleasurable and rewarding activity. Sure enough, as he and his colleagues began to work out the brain circuitry underlying the vocalization, they found that it overlapped with a reward pathway in the brain known to be activated during feelings of enthusiasm, joy, anticipation, and eagerness.

“Every place in the [pathway] that we stimulated, we got a chirp,” Panksepp says. “That’s the gold standard that [this vocalization] is [associated with] a big reward.” As the laughter is heard robustly during playtime, it indicates that play is in and of itself rewarding, or fun. But more important, rat laughter itself could provide the first objective measure of positive affect in nonhuman animals. This finding could lead to greatly improved animal models for psychiatric disorders, which currently rely on indirect measures such as sugar intake.

“If we take animal feelings seriously and develop ways to measure [them], [we can] profoundly increase our understanding of ourselves, especially at the lower levels where we’re so similar,” Panksepp says. “This is the first deep neuroscience of the mind.”



For years, animal play was an area of research plagued by criticism from skeptics. It used to be that “people had kind of written off play as a ‘garbage pail’ behavior,” says ethologist Marc Bekoff of the University of Colorado, who studies social play in wolves and coyotes. “They claimed animals don’t play, and we [just] assign a behavior pattern to the category of play when we can’t assign it to anything else.”

But within the last few decades, rigorously documented accounts of play behavior in a wide variety of mammals, as well as some bird species, have brought play research from laughable to reputable. “I don’t think anyone seriously denies play exists as a phenomenon,” Burghardt says. “I think where the main issues lie now are in the diversity and extent of play.”

Indeed, few will argue with the notion that puppies or kittens play, as they watch young litters romp around with their brothers and sisters. But even in these cases where play is seemingly obvious, defining the behavior has proven difficult—scientists can tell when a kitten is playing, for instance, but can’t say why they’re so sure that is what’s happening. And without formal criteria for play, it’s challenging for researchers to identify it in less obvious species.

Recognizing this problem, Burghardt set out to solve it by observing play in species accepted as demonstrating playful behavior, and using them to establish five criteria to help researchers identify play in unfamiliar species. The first is that the behavior is not fully functional. When animals play, they mimic various other functional behaviors, such as those involved in predation or mating, but in the context of play, these behaviors do not serve their usual function. Imagine a domestic dog wildly whipping around a stuffed toy, for example. While remarkably similar to the hunting behavior seen in wild dogs and wolves, this dog is not trying to kill and ingest its toy, but merely give it a good ride.

Some of his other criteria: the behavior is spontaneous or pleasurable, incomplete or exaggerated, repeated, and only occurs when the animals are well fed, healthy, and free from acute or chronic stressors. This last criterion has even prompted some researchers to suggest monitoring play as a proxy for animal welfare. In summary, as Burghardt has repeatedly defined it in his reviews: “Play is repeated behavior that is incompletely functional in the context or at the age in which it is performed and is initiated voluntarily when the animal (or person) is in a relaxed or low-stress setting.”

These criteria may explain why play appears to be so much more common in mammalian species, than in reptiles, fish, or invertebrates, Mather says. There are few situations where cold-blooded animals are safe, comfortable, and well fed, as they must constantly deal with regulating their body temperature, avoiding predators, and finding food. Conversely, mammals are warm-blooded and often have extensive periods of parental care, which provide a safe and comfortable

childhood. Cold-blooded animals in captivity, on the other hand, may find themselves in much more relaxing settings.

Applying these criteria to Pigface, Burghardt concluded that hitting the basketball around its enclosure could indeed be classified as play. “It fit the five criteria,” he says. “The behavior was certainly not functional in any obvious sense, it was certainly voluntary or rewarding because it did it repeatedly and spontaneously, and it was a behavior that was different than the normal behavior of that animal.”

Similarly, the criteria worked for the octopuses shooting the pill bottles across the surface of the water, Mather says. “You’re not allowed to call it play if they do this once or twice,” she says, but this “ball bouncing” happened “about 20 times.” It could be that the octopuses were bored, Mather adds, but that’s exactly the type of scenario where one would expect to see play.

Burghardt’s five criteria have also been used to identify play in a variety of other species, including fish, komodo dragons, and even insects. Sociobiologist Elisabetta Palagi of the University of Pisa in Italy, for example, used these criteria to classify some confusing behaviors in the paper wasp as play. When the wasps form colonies each spring, they must establish dominance hierarchies. This involves a ritualized behavior in which the dominant female beats her antennae over the head of the subordinate wasp, often licking, biting, and begging for food. But Palagi noticed similar behaviors just before their winter hibernation, when no dominance battles were expected. The winter behavior thus fit all five of Burghardt’s criteria, leading Palagi to suggest that the wasps were possibly playing, similar to play-fighting observed in young mammals.

The field has certainly not shed all of its skeptics, however, most of whom cite the lack of data. “There certainly are species that probably play,” says ethologist Judy Diamond, a professor and curator at the University of Nebraska State Museum, who studies play in birds with her husband Alan Bond. But “no systematic work has been done on their play. The question is whether people can come up with a rationale for why this is play and exclude other explanations.”

One of the “other explanations” many play researchers find difficult to rule out is that of exploratory behavior. When an animal plays with an inanimate object, for instance, it’s easy to confuse play with simple exploration, Diamond says. “How you separate object play from exploratory behavior is really quite difficult,” she says. “Of course it could be play, [but] it could be anything.” Even Pigface could have simply been exploring his environment, not playing with a basketball, says Bekoff. “It was one of those situations where you couldn’t really tell what in the world was going on unless you ask[ed] the animal.”

“My guess is that play is an offshoot of exploration,” says Mather, recalling the strong exploratory tendencies of the octopuses she has studied. The distinction, which is not an easy one to make, is that play should have fragments of other nonplay behaviors—the third of Burghardt’s five criteria—whereas exploration is expected to consist of longer bouts of investigation. “It’s the fragmentation you should be looking for in play, which you wouldn’t see in exploration,” she says.

Thus, by conducting studies of behavior that adhere strictly to Burghardt's criteria, many are warming up to the possibility that play might exist in a wide range of species outside of mammals. "It wouldn't surprise me," says Sharpe. "There does appear to be good evidence," at least in some species.

"To find play outside the realm of mammals is incredibly exciting [and] quite humbling, actually," says Lewis, a skeptic-turned-believer in nonmammalian play behavior. Furthermore, she adds, "It just challenges our view on the evolution [of play]. If play exists in all of these different [species], either play exists in everything, which we don't know that it does, or is this something that's so adaptive it's evolved repeatedly across lineages?"



While the debate over how wide-ranging the behavior is rages on, the concept of animal play is now generally accepted as a separate and important category of behavior. As such, the question is no longer if animals play, but why. And there's no easy answer.

To me, that's the most important question still— why do individuals engage in play? —Anthony Auger, University of Wisconsin–Madison

For most behaviors, says Sharpe, the function is clear, such as the use of aggression to win resources or mates. With less obvious behaviors, the general experimental approach is to stop the animals from doing the behavior and take a look at the effects. In a recent study of social grooming in meerkats, for example, the researchers treated the animals with insecticides to reduce the time they spent picking off ticks and fleas and found, surprisingly, that they became less aggressive. "But it's really difficult to stop an animal from playing without impacting other aspects of its behavior," Sharpe says.



Indeed, “in the 1960s and ’70s before the advent of ethics committees,” she adds, “a number of studies did just that—raising rats and monkeys in social isolation so they couldn’t play-fight, or confining young ungulates to small spaces so they couldn’t gallop and frolic.” While the researchers saw effects, they were “largely meaningless” because of all the other aspects of the animals’ lives that were affected by the experimental conditions, she says. “[So] no one’s been able to come up with any convincing, strong evidence that there’s a benefit at all.”

“To me, that’s the most important question still—why do individuals engage in play?” agrees neuroscientist Anthony Auger of the University of Wisconsin in Madison. “There [are] many theories, but I don’t know which is the best.” Because play exists in such a wide range of animals, social behavior researcher Giada Cordoni of VademECOS in Italy says it is likely “a behavior that is maintained by natural selection.” As such, “we can argue that play has some adaptive function.”

Perhaps play has a delayed benefit, but no immediate function. One leading theory is that play helps animals develop socially and cognitively, and, in highly social species, helps establish dominance hierarchies. Some of the strongest evidence for this hypothesis comes from comparative studies of closely related species. Bekoff’s research on canid species—which include coyotes, wolves, and domestic dogs—found that “the more social canids played more in early life,” he says. Furthermore, “the amount of play in early development is related to the later social organization [and] the complexity of the relationships that the animals form.”

A similar pattern was also seen in bird species in which play has been well documented, including parrots, corvids, and hornbills. In these birds, complex social play, such as the

rambunctious wrestling and synchronized wing-flapping and hopping behaviors observed in some parrot species, appeared more likely in species that lived in complex, social groups and maintained relationships after the juveniles fledged from the nest. This suggests that “one function [of play] might be that it ameliorates aggression,” says Diamond. “Play may have evolved as a mechanism to reduce fighting when there are selection pressures that prevent [juvenile] dispersal.”

Many scientists are also looking closely at the neuroanatomy of play behavior for clues to its role. “We tend to associate play, particularly the complex cognitive aspects of play like social play, with animals that are smart,” says Lewis. “So there’s this ongoing assumption that there should be this relationship between brain size and play behavior.” But when a comparative study of mammals showed that “absolute brain size tells us nothing,” she says, researchers started to look at particular regions of the brain that might affect the frequency and complexity of play behavior.

Looking at primates, researchers tied social play to the size of particular brain regions important in social cognition, finding that species with a larger cerebellum, neocortex, hypothalamus, and amygdala all engage in more social play. The findings corroborate the idea that animals are using social play to learn social rules, Lewis says. The amygdala and hypothalamus, for example, are “completely bound up in emotion and the socioemotive aspects of [social development],” she says. “Primates, being social, are naturally very keyed in to the points of view of others in their group, and they need to be able to do that to be successful as primates.”

Similarly, the cerebellum, involved in social learning, and the neocortex, the “thinking part of the brain,” seem important for learning how to respond in socially appropriate ways, Lewis says. “If you fail to learn how to react appropriately to things, you’re not going to make a good adult. Young animals have to play to make their adult brains better.”

In fact, studies using rats showed that one-third of genes in the neocortex were modified by play. “That means play is having a big effect on our higher brain,” says neuroscientist Jaak Panksepp of the College of Veterinary Medicine at Washington State University. “But we know that [the] higher brain is not needed for play,” he adds, “because we’ve taken it away and animals [still] play normally.”

Another popular theory says that play helps juveniles develop motor skills. “In [the] ’70s and ’80s, everyone thought [play’s function] was practicing physical skills—hunting in predatory animals or fighting in [species] like baboons and social animals,” says Sharpe.

In juvenile ground squirrels, for example, individuals who played more often and with many partners appeared to have improved motor skills. Because juvenile American kestrels prefer to play with objects that resemble prey, researchers have suggested the behavior helps hone their hunting skills in adulthood. Similarly, in populations of herring gulls that drop prey items to break them open for consumption, juveniles sometimes drop and re-catch prey before they hit the ground. Researchers have classified this as play behavior, possibly serving to improve the young birds’ foraging ability by strengthening muscles or solidifying neural connections important for dropping behavior.

But direct support for this hypothesis is lacking, and recently, “there’s been more of an emphasis [on how play] might be priming [animals’] more physiological [systems], like their stress response,” Sharpe says. “When animals play they use the same neurochemical receptors that are used in [dealing with stress],” she explains. “When young animals prime these systems, they respond to stress differently—they don’t get as stressed or anxious, and they recover quicker.”

This idea was formally conceived in 2001 and dubbed “training for the unexpected.” Because “the behavior of animals that play is more flexible,” says Cordini, “play seems to be useful to manage the uncertain situations.”

“Training for the unexpected seems to be a fairly global reason why animals play,” agrees Bekoff. “Across species, it seems that play really prepares animals to deal with unexpected circumstances in their social and physical environment because it gives them the opportunity to practice different variations on behavior.”

But while all of these hypotheses—social, cognitive, and motor development, and preparing for unexpected situations—are likely to play a role in why play behavior evolved, the evidence for these benefits remains sparse. Furthermore, biologists are now beginning to realize that play may also serve an immediate function, as play has recently started to be documented in adults as well. “It’s difficult to think that adult play may work for developing motor skills,” Palagi says.

Instead, Palagi and her colleagues found evidence that adult play in chimpanzees served to help them to cope with their competitive tendencies just before feeding time. Similarly, a study of adult Japanese macaques that continue to play with stones as juveniles do suggested that the behavior is psychologically relaxing, and may help maintain neural pathways and slow the cognitive degeneration associated with aging.

“The context is very important for definition of the possible roles of play,” Cordini says. “I’m quite sure that play has got various functions depending on the species, the sex, the age, the social context and environment. It’s a very complex behavior, and because it’s complex, it’s very interesting.”

BURGHARDT’S FIVE CRITERIA FOR PLAY

- 1- Play is not fully functional in the form or context in which it is expressed.
- 2- Play is spontaneous, voluntary, and/or pleasurable, and is likely done for its own sake.
- 3- Play is incomplete, exaggerated, or precocious.
- 4- Play is repeated but not in exactly the same way every time, as are more serious behaviors.
- 5- Play is initiated when animals are well fed, healthy, and free from acute or chronic stressors.

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