

# Play in bats: general overview, current knowledge and future challenges

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**Abstract.** Although virtually all young mammals play, this particular behaviour is still poorly studied. So far little is known about play in bats. As reported in Leen & Novick (1969) the young of the free-tailed bats, *Tadarida brasiliensis*, “all joint together for the greater part of the day or night to play and tussle”. Neuweiler (1969) gives an account of a mother-offspring play in *Pteropus medius*. Some social play has been reported in vampire bats (*Desmodus rotundus*). The occurrence of babbling in some species attests to the humanlike development of audio-vocal communication in bats, as found in *Saccopteryx bilineata*. From a neural and functional perspective, babbling may be equivalent to play behaviour. A few personal observations are mentioned: on *Pteropus seychellensis* in Praslin, Seychelles; on *Pteropus medius* in Viharamahadevi Park, Colombo (Sri Lanka); on *Pteropus rodricensis* on Rodrigues (Mauritius, Indian Ocean). It could be helpful to study bat play in captivity, even during periods of rehabilitation.

**Animal behaviour, ethology, *Pteropus medius*, *Pteropus poliocephalus*, *Pteropus seychellensis*, *Pteropus rodricensis*, *Tadarida brasiliensis*, *Saccopteryx bilineata*, *Desmodus rotundus***

*PLAY is older than culture, for culture, however inadequately defined, always presupposes human society, and animals have not waited for man to teach them their playing. We can safely assert, even, that human civilization has added no essential feature to the general idea of play. Animals play just like men. (Johan Huizinga)*

## Introduction

The study of animal behaviour, and of animal play in particular, did not develop until after the writings of Charles Darwin. In his book *The Descent of Man and Selection in Relation to Sex* (1871), he wrote: “Happiness is never better exhibited than by young animals, such as puppies, kittens, lambs, etc., when playing together, like our own children”. In 1872 Darwin published *The Expression of the Emotions in Man and Animals* in which he asserted that all humans, and even other animals, show emotion through remarkably similar behaviour.

The first modern scholar on animal play is Karl Groos; in his classic book (Groos 1898) he suggested that play has the value of exercise necessary for animals to develop instinctive behaviour. According to Fagen (1981) “play and a highly developed cerebral cortex go together”, suggesting that not the overall brain size is important, but the relative size of the neocortex (Iwaniuk et al. 2001). Play is useful to the normal process of evolution by natural selection; when animals play, they are practising basic instincts for survival. Even if though virtually all young mammals play, as adults of many species, this particular behaviour in animals is still poorly studied and is still relatively unknown (Smith 1978, Fagen 1981, Burghardt 2005, Graham & Burghardt 2010). Defining play is difficult to do, which is the reason why there are so many definitions. Fagen (1981)

lists 37 different ones and Wilson (1975) wrote that “no behavioral concept has proved more ill-defined, elusive, controversial and even unfashionable than play”. One of those most cited is that of Burghardt (2005): “Play is repeated, incompletely functional behavior differing from more serious versions structurally, contextually, or ontogenetically, and initiated voluntarily when the animal is in a relaxed or low-stress setting”. Other researchers found that play might have immediate benefits and not only delayed ones, but none of these benefits, immediate or delayed, had been empirically confirmed (Martin & Caro 1985).

Play in animals is usually classified in three different types: *locomotor play*, *object play* and *social play*, and they can occur at the same time too (Fagen 1981). Five criteria were defined by Burghardt (2005) to characterize a behaviour as play, if all come together. The *first criterion* is that the behaviour is not fully functional, i.e. it does not contribute to current survival. The *second criterion* is that the behaviour is spontaneous, voluntary, pleasurable. The *third one* is that the behaviour differs from the formal performance of a typical ethological behaviour in at least one respect: incomplete, exaggerated or other behaviour patterns with modified way of execution. The *fourth criterion* is that the presumed play actions can be repeatedly observed during at least a portion of an animal’s life. The *fifth criterion* is that the behaviour is initiated only when an animal is adequately fed, healthy and free from stress. Not surprisingly, sick animals play less than healthy ones (Fagen 1981), and lack of play may be one of the first symptoms of illness. The higher rates of play seen among captive animals are commonly attributed to unlimited food resources and the absence of predators. “Fun for its own sake” is the subtitle of the chapter on “Play” by Balcombe (2006). There are at least four good reasons to believe that animals are having fun when they play. First, they look like they are having fun. Second, humans enjoy playing, and much of our play resembles that of other animals. Third, animals want to play. Fourth, there are chemical changes in the brains of playing animals that suggest they enjoy it (Byers 1998, Siviy 1998, Balcombe 2006, Pellis & Pellis 2010a). Adult animals, in particular, seem to show more play in captivity as this condition might represent a regression to a more infantile state, since in captivity virtually all of an animal’s needs are provided for (Fagen 1981). According to Špinka et al. (2001) the main function of play is to allow animals to develop the physical and psychological skills to handle unexpected events in which they experience a loss of control; “play functions to increase the versatility of movements used to recover from sudden shocks such as loss of balance and falling over, and to enhance the ability of animals to cope emotionally with unexpected stressful situations” (Špinka et al. 2001). Špinka and his collaborators list twenty-four predictions that emerge from their hypothesis. Play helps connections among neurons in the cerebellum, a brain region particularly important in motor coordination and memory of motor patterns (Byers & Walker 1995). Particular parts of the brain are associated with more play; where we found positive relationships between brain size and play, they involve specific areas of the brain and specific types of play (Pellis & Pellis 2010a). Recently *Current Biology* has published a special number entitled *Biology of Fun 25th Anniversary Special Issue* (Volume 25, 2015) with articles and reviews on this topic.

## Current Knowledge

Bats are very successful and specialized mammals and provide many hints and opportunities to study their behaviour even on the evolutionary side but so far little is known about play in bats. Their nocturnal habits make difficult to determine different behaviours in Chiroptera (more than 1300 species), living all over the world, except Antarctica, in every habitat (Fenton & Simmons 2015). Their complex diversity shows many different social and individual behaviours. Jonathan

Balcombe (2006) watched bats pursue flying tennis balls, hats and frisbees, and it is hard to conclude that an animal could mistake these objects for prey using an echolocation system capable of discriminating different insect species. Their behaviour suggests at least curiosity, and perhaps play. As reported in Leen & Novick (1969), the young of the free-tailed bats, *Tadarida brasiliensis*, “all joint together for the greater part of the day or night to play and tussle, stage sham battles and pursuits, and otherwise romp in a fashion which reminds one of a litter of puppies or kittens”. Neuweiler (1969) gives an account of mother-offspring play in *Pteropus giganteus* [= *P. medius*]. Play fighting between mother and young seems addressed to train the young to adulthood. Some social play has been reported in vampire bats (*Desmodus rotundus*), which show a highly developed social behaviour, included reciprocal altruism in blood sharing. Young vampires play together slapping each other with their wings, chasing and sniffing each other (Schmidt & Manske 1973). Grooming (including social grooming) is well spread out in bats, particularly in flying foxes and in vampire bats. Social grooming may serve purposes other than ectoparasite control in species with complex social behaviour. This activity stimulates the release of beta-endorphin, which is one physiological reason for why grooming appears to be relaxing and this behaviour could be regarded, in some respects, as a playful activity. “Social grooming and rough-and-tumble play, along with caressing and hand-shaking, have something important in common, touching ... It is possible that social play originates from social grooming, or, alternatively, that the two are both facets of the same coin – both are attempts to alter a partner’s affective state, with situational factors dictating which is the most appropriate.” (Pellis & Pellis 2010b).

Precursors of echolocation calls of young bats may serve a communication function during the first week prior to its modification and thereafter be used for orientation and navigation, which becomes increasingly important for the survival of young bats. The occurrence of babbling in some species attests to the humanlike development of audio-vocal communication in bats, as found in *Saccopteryx bilineata*. From a neural and functional perspective, babbling may be equivalent to play behaviour (Knörnschild et al. 2006, Kanwal et al. 2013).

Object play has not been specifically described in bats but the film of several species of fruit bats by the Lube Foundation provides suggestive evidence for object play using the five criteria defined by Burghardt (2005). Adult animals seem to show more play in captivity and this might represent a reversion to a more infantile state, since in captivity virtually all needs are available without trouble, with unlimited food resources and absence of predators.

In his study on the behaviour of Australian Pteropodidae (mainly on *Pteropus poliocephalus*), Nelson (1965) introduces several references to play behaviour. One of the different groups that are present in the breeding camps are juvenile packs and their members are very active, mutually grooming and “playfully” fighting and smelling each other. Even in these situations we can see the connections already mentioned between grooming (useful to establish social bonds) and play behaviour. In early winter, the behaviour of the juveniles is similar to their behaviour in the juvenile packs of the summer camps, where mutual grooming and playful fighting are common. The aggressive behaviour is learnt from the male in the family and later by play in the juvenile group. Baby flying foxes recognize one another, and they may form close friendships during their long lives. Wrestling and play-fighting are common components of their play: two photos (in Balcombe 2011 and in Jones 2013) show a mother and her pup engage in a bout of play-fighting.

This behaviour has been confirmed by my observations made in different areas of the world, especially concerning megabats. During my study trip in 1984 to the Seychelles (Indian Ocean), I observed the behaviour of some groups of *Pteropus seychellensis* on Praslin, the second largest island. Many of them live on takamaka trees (*Calophyllum inophyllum*); they do not sleep quietly during the day and are often noisy and squabble with their neighbours and engage themselves in

play-fighting, tussle, play-chasing, even adult animals show this behaviour. In 1996 I observed a similar behaviour in *Pteropus medius*, one of the largest bats, in the Viharamahadevi Park in Colombo, the capital city of Sri Lanka. During my stay in the island of Rodrigues (Indian Ocean) in 2003, I observed several different behaviours of the endemic *Pteropus rodricensis*, already reported especially in captivity (Carroll 1979, Young & Carroll 1989): “play chase” by immature bats flying to one location and rapidly leaving; “play wrestle” involves close belly contact between individuals, with restrained biting on the neck; a pair of bats, or even a group wrestling together, often adult females, rarely adult males; sometimes chase and wrestle alternate in long play sessions. Play in Chiroptera was rated as 1.0 by Iwaniuk et al. (2001); a group of very playful animals, Primates, was rated as 3 (complex play). Burghardt (2005) raises the ranking of bats to 1.5, based on vampire and fruit bat behaviour.

### Future Challenges

It could be helpful to study bats in captivity, even during periods of rehabilitation. In addition, the observation of the behaviour in zoos can give interesting results, although it may chiefly concern the flying foxes, which are easier to raise. However we should be very cautious about drawing any conclusions, as there are many examples of behaviours studied under artificial conditions that, when re-examined by ethologists under natural conditions, have turned out to be distorted (Aldis 1975). The observation of animals in the wild and in captivity must complement each other, and it is idle to argue about the methods to be preferred (Eibl-Eibesfeldt 1995, Martin & Bateson 2007, Kleiman et al. 2010, Rees 2015). It is also advisable neither to overuse statistical techniques nor to overindulge in them (Martin & Bateson 2007).

Fagen (1981) regards as rigorous observers admit that watching the game of animals is aesthetically pleasing. Therefore it is interesting to quote some passages of the book *The White Lady* by Leonard Dubkin (1952), an American author and naturalist from Chicago. This is a sweet story about an albino little brown bat (*Myotis lucifugus*) he calls “The White Lady”, full of interesting ethological observations. He saw her grow and learn to fly. Dubkin reports these young little brown bats scrambling about and biting “playfully” and at a later age many young bats would play in a group, squeaking and biting or crawling over and under each other. Morphologically and ecologically, *Myotis daubentonii* is the Palearctic equivalent of *M. lucifugus*, living in North America (Fenton & Barclay 1980), even though phylogenetically very distant (Ruedi & Mayer 2001). This is one of the very few accounts of play in microbats.

“As in the case of other animals, the play of young bats evolves gradually as they mature. However, in the case of most other animals there is almost always more than one baby in a litter, and the tendency to play with its brothers and sisters is natural almost from birth. But bats are born singly, they have no brothers or sisters, and as far as I could observe there is no play activity until the young are old enough to be left alone in the grotto all night. This may or may not be due to the fact that until that time their eyes are not yet open. At any rate, two young bats hanging side by side from the roof never show any interest in each other, or any impulse to play, until they are about a week old.” ... “After a few days of this sort of random exploratory activity she began to spend more of her time with the other young bats she met among the vegetation. At first it was usually she and one other bat who would play together, but occasionally a third would join them. They would scramble about among the vines and creepers, chasing or being chased, biting each other playfully, squeaking the high, nasal squeak of very young bats. Once I saw her threading her way through the vegetation with her jaws firmly clamped on the hind leg of another young bat who was crawling in front of her, and she did not let go her hold until both fell to the floor.

Their play at this period of their childhood seemed to consist entirely of chasing and biting each other, and squeaking. Gradually, as she became older, her play activity became more complex, and she became involved in relationships with more and more of the other young bats. I would often see her among a group of forty or more young bats, all of whom were squeaking and biting and crawling over and under each other in what appeared to me to be some elaborate game, the rules of which I could not possibly understand. Sometimes early in the evening, just after their mothers had left, a few of the bats would engage in a game that always reminded me of a jousting tournament” (Dubkin 1952).

Huizinga (1949) wrote: “PLAY is older than culture, for culture, however inadequately defined, always presupposes human society, and animals have not waited for man to teach them their playing. ... Animals play just like men”. Attempts to deprive animals of play almost invariably affect other aspects of behaviour than play itself, such as social or object interactions of a non-playful sort (Burghardt 2005, 2010). Play deprivation may take many forms on a spectrum of disadvantage also in children (Gray 2011) and it is reasonable that studies in animal play may also be fruitful to humans. A very interesting summary of play in humans and animals is “Taking play seriously” by Robin Marantz Henig (2008). The author explores the biological and sociological research on play in animals, children, and adults, with stimulating comments.

## Souhrn

**Hra u netopýřů: obecný přehled, současné znalosti a výzvy do budoucna.** I když si prakticky všechna mláďata savců hrají, toto zvláštní chování je stále málo prostudováno. Dosud je málo známo o hře a hraní u netopýřů. Jak popsali Leen & Novick (1969), mláďata morouse guánového (*Tadarida brasiliensis*) “se všechna spolu sdružují na velkou část dne nebo noci, aby si hrála a prala se”. Neuweiler (1969) podává zprávu o hře matky a mláďete kaloně indického (*Pteropus medius*). Jisté společenské hry byly popsány také u upírů (*Desmodus rotundus*). Výskyt “brblání” u některých druhů svědčí pro podobný vývoj audio-vokální komunikace u netopýřů jako u lidí, jak bylo popsáno u sakokřídlece bělopruhého (*Saccopteryx bilineata*). Brblání může být – z neurálního a funkčního hlediska – obdobou hravého chování. Uvedeno je několik osobních pozorování: u kaloně seychelského (*Pteropus seychellensis*) na ostrově Praslin (Seychely); u kaloně indického (*P. medius*) v parku Viharamahadevi (Colombo) na Cejlonu; u kaloně rodrigueského (*P. rodricensis*) na ostrově Rodrigues (Mauritius), vše v Indickém oceáně. Jistě by pomohlo studium hry u netopýřů v zajetí, například jsou-li chováni po době rehabilitace po zranění, apod.

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