

# 6 Evolutionary Functions of Play

Practice, Resilience, Innovation, and Cooperation

Peter Gray

Peter Gray. Evolutionary functions of play: Practice, resilience, innovation, and cooperation. In P. K. Smith & J. Roopnarine (Eds.), *The Cambridge Handbook of Play: Developmental and Disciplinary Perspectives* (pp 84-102). Cambridge, UK: Cambridge University Press. 2019.

Nobody has to teach young mammals to play. They come into the world biologically designed for it. Why? Why would natural selection have promoted a class of behavior that, almost by definition, looks purposeless? Play clearly has costs. It uses energy; it is sometimes noisy and attracts predators; and some common forms of it can produce injuries. From an evolutionary perspective, play is either an accident – a side effect of evolution that natural selection could not weed out – or it does, after all, serve adaptive functions that outweigh the costs. The assumption underlying this chapter, backed up by a great deal of research, is that play is no accident.

Play comes in many forms and probably serves a wide variety of life-promoting ends. Among the categories of functions supported by research and theory, four stand out. Play may be a means by which individuals (1) practice skills that are essential to their survival and reproduction; (2) learn to cope physically and emotionally with unexpected, potentially harmful events; (3) generate new, sometimes useful creations; and (4) reduce hostility and enable cooperation.

This chapter begins with a section on how play is identified and then proceeds through sections devoted to each of the four just-listed categories of putative functions. Although play may exist in a wide variety of non-mammalian species as well as mammals (Burghardt, 2005), the focus here is solely on mammals, with special attention to humans.

## Definitions of Play

Researchers who study play in humans commonly emphasize that play is defined not so much by the specific actions involved as by the attitudes and motives underlying those actions. Two people might be doing the same thing – maybe pounding nails with a hammer – and one might be playing while the other is not. In his classic book *Homo Ludens*, Johan Huizinga (1938/1955, p. 13) summed up an extended definition of play with these words: “Play is a free activity standing quite consciously outside ‘ordinary’ life as being ‘not serious,’ but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can

be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner.” In his influential essay, *The Role of Play in Development*, Lev Vygotsky (1978, pp. 93–94) characterized play as activity that is “desired” by the player, “involves an imaginary situation,” and “always involves rules.”

Drawing partly from these and other classic and contemporary definitions, I have elsewhere defined play, for humans, as activity that has the five characteristics listed in the following paragraphs (Gray, 2012a, 2013). As I list them, I will comment briefly on how each characteristic provides some clue concerning play’s value in children’s development. It is also worth noting that play can occur in matters of degree. An activity may be more or less playful depending on the degree to which each of the characteristics listed here is present.

1. *Play is self-chosen and self-directed.* Play, first and foremost, is what one wants to do, as opposed to what one feels obliged to do. An activity motivated by coercion or necessity, real or perceived, rather than by free choice is not play. Players choose not only to play, but also how to play. If there is a coach involved, telling the “players” what to do, it is not play, or at least not fully play. Thus, play may be a means by which children learn how to take control of their own lives, a means of practicing independence. In social play (play involving more than one player), the players must decide together what and how they will play. Thus, play may be a vehicle for learning to negotiate, compromise, and cooperate.

2. *Play is intrinsically motivated.* Play is activity that, from the conscious perspective of the player, is done for its own sake, not for some reward outside itself. Play may have goals, but those are experienced as part and parcel of the activity, not as the primary reason for the activity. For example, constructive play (the playful building of something) is always directed toward the goal of creating the object that the player has in mind; but the primary objective is the *creation* of the object, not the having of the object. Similarly, competitive play is directed toward scoring points and winning, but if the activity is truly play, then it is the process of scoring and winning that matters to the player, not some subsequent consequence of having scored and won. When people are *not* playing, they typically take the most direct, least effortful route that they know to achieve the goal. When they are playing, however, they may try a variety of routes, including novel ones that may be quite inefficient. Thus, play may be a means to try out new ways of behaving, some of which might prove useful later, in serious contexts.

3. *Play is guided by mental rules, but the rules leave room for creativity.* Play is freely chosen activity, but not free-form activity. Play always has structure, which derives from rules in the players’ minds about what is permitted or not. Players may change rules as play progresses, but if rules are abandoned completely play dissolves. The rules provide boundaries within which the actions must occur, but they always leave room for creativity. Thus, play

may provide practice at being creative within the bounds of rules. In social play, the rules must be understood and agreed on by all the players. For example, in a play fight, the rules might include “no biting, scratching, kicking, or punching, and if you throw someone it must be upon something soft.” You must go through the motions of fighting without actually hurting the other person. The rules might be implicit rather than explicit, but if a player violates one, the other players are likely to make it explicit. The rule-based nature of play is the characteristic that Vygotsky (1978) emphasized most strongly, as he contended that play is the primary means by which children learn to control their impulses and abide by socially agreed-on rules, a skill that is crucial for human social life.

4. *Play is imaginative.* Play always involves some degree of mental removal of oneself from the immediately present real world. This is the characteristic that Huizinga (1938/1955) emphasized most strongly as he built his argument that play provides the engine for cultural innovations. This is also the characteristic emphasized by researchers who focus on the role of play in the development of creativity and the ability to think in ways that go beyond the concrete here-and-now. Imagination underlies all higher-order human thinking. The ability to think hypothetically, or about anything that is not immediately present, involves imagination, and children continuously practice imagination in play.

5. *Play is conducted in an alert, active, but relatively non-stressed frame of mind.* This final characteristic follows naturally from the others. Because play involves conscious control of one’s own behavior, with attention to means and rules, it requires an active, alert mind. Yet because play is not a response to external demands, because it takes place in a fantasy world, and because the ends do not have immediate real-world consequences, the person at play is relatively free from pressure or stress. Some degree of mental tension may arise, as players challenge themselves and strive to perform well; but, as play is always self-chosen, so is any tension that accompanies it. If the tension becomes too great, the player is free to quit or change the structure of the play at any time and thereby relieve the tension. This state of mind – of relaxed alertness and absorption in the activity – is the state of mind that Mihalyi Csikszentmihalyi (1990) has called *flow*. In fact, Csikszentmihalyi’s first publications on flow were explicitly about the mental state accompanying play (Csikszentmihalyi, 1975a, 1975b). This state of mind has been shown, in many psychological research studies, to be ideal for creativity and the learning of new skills (Csikszentmihalyi, 1990; Gray, 2013).

Researchers who study play in non-human animals have no direct way to ask their subjects about attitudes or motives. They must rely entirely on non-verbal behavioural cues to decide whether an activity is play or not. Generally, the clues are indications that the actions are being conducted in such a way

that they are not effective in achieving a serious, immediate, survival-promoting goal. Perhaps the most often-quoted definition of animal play is the one offered originally by Bekoff and Byers (1981): “Play is all activity performed postnatally that appears to have no obvious immediate benefits for the player, in which the motor patterns resembling those used in serious functional contexts may be used in modified forms. The motor acts constituting play have some or all of the following structural features: exaggeration of movements, repetition of motor acts, and fragmentation or disordering of sequences of motor acts.”

One way to envision how this definition might apply is to imagine the difference between a cat that is seriously *preying* on a mouse and one that is *playing* at preying on a mouse. The former takes the quickest route for killing the mouse. The latter tries various ways of catching the mouse, not all very efficient, with perhaps some exaggerated pouncing on, scurrying after, and batting at the mouse rather than biting, and then lets the mouse go each time so it can catch it again. For the preying cat, the reward is the delicious mouse. For the playing cat, the reward is the act of catching or trying to catch the mouse.

Absent from most definitions of animal play is any reference to imagination or fantasy. There is no way at present to know if animal play is accompanied by imagination as human play is. For example, there is no way to know if rats engaging in a play fight understand it to be a pretend fight. It is entirely possible that the rats experience a play fight and a real one as entirely distinct, such that one is in no way symbolic of the other.

### **Play as Practice of Survival-Promoting Skills: Karl Groos’s Theory**

Without question, the leading pioneer in applying evolutionary theory to the study of play was the German philosopher and naturalist Karl Groos, whose work has not received the attention it deserves. Well before a scientific consensus had been reached on Darwin’s theory of evolution by natural selection, Groos applied that theory in a remarkably insightful analysis of play in two books, published originally in German as *Die Spiele der Tiere* (1896) and *Die Spiele der Menschen* (1899) and subsequently in English as *The Play of Animals* (1898) and *The Play of Man* (1901).

According to Groos, “the higher animals,” especially mammals, come into the world with incompletely formed neuromuscular systems and behavioural repertoires. In order to become competent adults, who can fend for themselves, they must exercise their bodies and practice behaviours that are essential to their survival. Play, he contended, is the means of such exercise and practice. In *The Play of Animals* (pp. 23–24), he wrote: “Without it [play in youth] the adult animal would be but poorly equipped for the tasks of life.

He would have far less than the requisite amount of practice in running and leaping, in springing on his prey, in seizing and strangling the victim, in fleeing from his enemies, in fighting his opponents, etc. The muscular system would not be sufficiently developed and trained for all these tasks. Moreover, much would be wanting in the structure of his skeleton, much that must be supplied by functional adaptation during the life of each individual, even in the period of growth.”

Groos’s theory explains some rather obvious facts about play. It explains why young animals play more than older ones: they play more because they have more to learn. It explains why those animal species that depend least on rigid instincts and most on learning, for survival, play the most. And it explains the different ways of playing that are seen in different species. To a considerable degree you can predict how an animal will play by knowing what skills it must develop to survive and reproduce. For example, young predatory animals play at chasing or stalking and pouncing on prey-like objects, including one another. In contrast, predatory animals play at fleeing and dodging, and in their chasing games they show more interest in being chased than in chasing (Groos, 1898).

At Groos’s time, a prominent theory of play was the “surplus energy theory,” which held that play is a by-product of the high level of energy and free time that young animals have. Groos argued that, from a Darwinian perspective, this theory was backward. He wrote (1898, p. 75): “Animals can not be said to play because they are young and frolicsome, *but rather they have a period of youth in order to play*; for only in so doing can they supplement the insufficient hereditary endowment with individual experience, in view of the coming tasks of life.” In *The Play of Animals*, he categorized varieties of play into domains important for survival, including movement play (playful walking, running, leaping, etc.), predatory play, fighting play, nursing play (playful care of young), and love play (play associated with mating).

In *The Play of Man*, Groos extended his insights about animal play to humans. He noted that young humans practice the same categories of skills in play that other mammals practice, but also practice skills that are uniquely human. Concerning the latter, he wrote about language play and constructive play, and he devoted a rather large section to “playful use of the mental abilities,” in which he described how children exercise their memory, imagination, attention, and reasoning in play. He also pointed out that humans, unlike the young of other animals, must learn not just the skills that are crucial to their species everywhere but also skills that are unique to the culture in which they are growing up. Therefore, he argued, natural selection led to a strong drive, in human children, to observe the activities of their elders and incorporate them into their play. He referred to this as “imitative play” but made it clear that the imitation is not blind. Children expand, in their play, on the kinds of behaviours that they see in adults and modify them creatively.

### Subsequent Evidence Concerning Play as Practice in Animals

Since Groos's time, much research has been conducted that bears on his practice theory of animal play. Here is a small sample.

In line with Groos's theory, sex differences in play, like species differences, generally reflect differences in skills needed in adulthood. In species where adult males fight for mating opportunities, young males regularly engage in more play fighting than young females (Meaney et al., 1985). As another example, Kahlenberg and Wrangham (2010) observed that young female chimpanzees, much more often than young male chimpanzees, played with sticks as if they were infants. They would carry a stick in ways resembling a mother's carrying of an infant, tucked between their abdomen and thigh, and would often take the stick into their day nest and play with it in a manner resembling maternal play with an infant. Consistent with the idea that this is practice for motherhood, such play peaked in the late juvenile period (around 8 years) and was never observed to occur after a female had given birth to her first infant.

Gomendio (1988) studied the timing of various forms of play in Cuvier's gazelles. During their first three months of life, young gazelles are in what is called the "hiding" stage of their development. Their main defence against predation is to remain hidden, and when a predator is near they freeze rather than run. This is also the period in which they most frequently play in ways that resemble the ways that older gazelles escape from predators. Their locomotor play at this stage consists of quick starts and stops, sudden leaps, and much twisting and turning. Gomendio suggests that the timing of such play is consistent with the idea that it prepares the youngster to leave the hiding stage. Only after the movements have been well practiced in play does the fawn stop hiding and start fleeing to avoid predation.

Byers and Walker (1995; also Byers, 1998) proposed a "motor training hypothesis" of play that is a direct derivative of Groos's more general practice theory. According to this hypothesis, early play provides the experience needed for the nervous system to develop the connections required for subsequent effective motor activity. As support of this hypothesis, they presented data showing that peak periods of play in house mice, Norway rats, and domestic cats correspond, in each species, with a sensitive period of neural development, in which connections are formed that permanently influence the animal's capacities to move in rapid, well-coordinated ways. In particular, during this period neurons in the cerebellum that are involved in the rapid timing and sequencing of muscular movements, and muscle fibres and motor neurons innervating them, are undergoing a final phase of differentiation.

Another research approach has been to map in detail the behaviour patterns of play and compare them with the patterns of the adult behaviour for which the play may be preparation. This approach has led Pellis and his colleagues to suggest that play fighting, at least in some species, may not effectively prepare

animals for serious fighting, but might serve other purposes instead (Pellis & Burghardt, 2017). In rats, mice, hamsters, and other murid rodents, the seemingly most difficult movements of play fighting resemble adult precopulatory behaviour more than adult fighting (Pellis et al., 2014). Interestingly, Groos (1898) also speculated that play fighting might, in some species, be rehearsal for sex more than for fighting.

A number of field studies have addressed the question of whether frequent play in youth correlates reliably with a survival or reproductive advantage later in life. A study of free-living yellow-bellied marmots revealed that those who played most as juveniles were the most likely to gain high dominance status in adulthood (Blumstein et al., 2013). In another study, juvenile social play correlated positively with adult reproductive success in female Belding's ground squirrels (Nunes, 2014). In a rather heroic study of brown bears in Alaska, Fegan and Fegan (2009) assessed various measures of the behaviour and health of cubs and their mothers during the cubs' first summer. They found that the best predictor of which cubs would survive the winter and through the next summer was play. Those cubs that played the most were most likely to survive. It is not clear why, but the researchers suggest that play allowed the cubs to develop the physical and emotional resilience needed to confront any of a number of possible survival challenges.

### **The Role of Play in Children's Natural Ways of Educating Themselves**

Groos is much more often referred to by researchers who study animal play than by those who study human play. In fact, Groos's *The Play of Man* was out of print for many years because there was no demand for it. Yet *The Play of Man* is in some ways the more profound book of the two and deserves the attention of anyone interested in child development and education. Groos described his theory as a theory of play, but, as I have argued elsewhere (Gray, 2013, 2016a), it is also a theory of education.

Education, broadly defined, is cultural transmission. It is the set of processes by which each new generation of humans acquires and builds on the skills, knowledge, lore, and values of the previous generation. We humans are the cultural animal and, as such, are, by nature, the educative animal. Beginning at least 2 million years ago, early humans began moving along an evolutionary track that made them ever more dependent on education. They developed means of hunting, gathering, processing foods, protecting themselves from predators, courtship, birthing, caring for infants, navigating their environment, and cooperating with one another that were culture specific and passed from generation to generation. In any cultural group, children who failed to acquire crucial aspects of their culture would be at a serious survival and reproductive disadvantage, so natural selection would strongly favour

characteristics that promoted children's desires and abilities to acquire the culture. If Groos's theory is correct, the expansion of play was a big part of this evolutionary change. According to Groos, children come into the world designed by natural selection to attend to the skills, ideas, and values of their culture and practice and rehearse them in play.

In Groos's theory, children play at species-specific skills, like other young mammals, but their ways of playing even at these are influenced by the culture. They play at all sorts of natural locomotor activities – walking, running, jumping, climbing. But then, depending on culture, the locomotor play may move on to such culture-dependent forms as paddling dugout canoes, riding horses, or skiing. They play rough-and-tumble games, but the nature of these games can depend on culture. For example, Fry (1992) found that children growing up in a village where there was much physical fighting among adults played at fighting more than children growing up in an otherwise similar but more peaceful village.

Children in all cultures acquire language through play. Their earliest production of language-like sounds (cooing and babbling) and first words always are playful (Bloom & Lahey, 1978). Later, children playfully rehearse more complex linguistic constructions, sometimes in monologues when alone (e.g., Kuczaj, 1985). But, of course, their language play is influenced by culture. Infants gradually restrict their babbling to the phonemes of their native language and, later, play with the words and grammatical constructions of that language. Children everywhere also engage in constructive play, thereby exercising the crucial human skill of building things, but what they build depends on what they see in the world around them. And, as Groos pointed out, children everywhere play in ways that exercise the human mental capacities of imagination and reasoning, but the scenes they imagine and the ideas they rehearse in such play derive from the culture.

The most compelling evidence for the role of children's play in education comes from observations in hunter-gatherer cultures. During all but the last 10,000 years or so, all humans were hunter-gatherers. A few such cultures, in isolated parts of the world, survived into the mid- to late twentieth century and were studied by anthropologists. Several years ago, I reviewed the literature on children's lives in such cultures and supplemented that with a survey of ten anthropologists who, among them, had spent significant amounts of time in seven different hunter-gatherer cultures on three different continents (Gray, 2009, 2012b).

A message that came through in all of these reports is that children, including adolescents, in these cultures were free to play and explore essentially all day, every day, and they spent much of their time playing at activities that were essential to success in their culture. Digging up tubers, fishing, cooking, caring for infants, climbing trees, building vine ladders, building huts, using knives and other tools, making tools, building rafts, making fires, defending against make-believe predators, imitating animals (a means of identifying

animals and learning their habits), making music, making musical instruments, and dancing were all mentioned by one or more respondents. The specific lists differed from culture to culture, in accordance with differences in the skills exemplified by adults in each culture. In all of these cultures the boys played endlessly at tracking and hunting, which are especially difficult skills to learn. Nobody had to require or even encourage children to play in these ways. They played at these activities because they saw them as important in the world in which they were growing up. They played mostly in age-mixed groups, away from adults, and younger children learned from older ones in the context of their play.

Boyette (2016) has systematically studied children among the Aka, of the Congo Basin in Africa, the largest group of people still living a hunter-gatherer way of life (see Chapter 17, this volume). He classified play into various types and found that about a third of all the play he observed was pretend play, in which children typically acted out activities they observed regularly among adults. As an example, he described a scene in which two boys, roughly 7 and 10 years old, assembled a miniature version of a *pendi*, the type of bark basket that adults use to collect honey, and then “tied a long forest cord to the *pendi* and ascended the tree to perform the conventional motions of chopping a hole in a limb to open the bees’ nest, pulling up on the *pendi*, and filling the leaf-lined container with imaginary honey to be lowered down to those waiting below.”

As another example, Bock (2002) found that young girls, among people in Botswana involved in farming as well as hunting and gathering, engaged frequently in “play pounding,” mimicking the actions that older girls and women used in processing grain. They would use a stick to simulate a pestle and imagine a mortar. He found that such play began at about age 3, peaked at about age 6–8, and then declined rapidly. About age 8 is when girls in this culture began to process grain with mortar and pestle as part of their family work. Bock’s observations, and his testing of young girls’ efficiency in actual grain processing, suggested to him that their pretend play significantly improved their efficiency in actual grain pounding, a task that requires considerable skill as well as strength.

In a review of anthropological research on education worldwide, Lancy (2016) concluded that nowhere outside Western or Westernized cultures is verbal teaching common. Everywhere, children learn primarily by observing, listening, and then incorporating what they see and hear into their play with other children. Such findings provide strong support for Groos’s theory. Elsewhere I have reviewed evidence, based partly on research at a radically alternative school in Massachusetts, that children in our modern culture who are provided with an appropriate learning environment, including a mixed-age group of playmates, learn such skills as reading, writing, and numerical calculations quite efficiently through observing and playing with children who have already acquired these skills (Gray, 2013, 2016a, 2016b).

## Play as Training for the Unexpected and as Fear Management

Play often involves exaggerated, inefficient, sometimes awkward and unbalanced movements, quite different from what one might expect if it were practice for serious, skilled tasks. Miller (1973) has referred to this as the “galumphing” quality of play. Young mammals also often play in risky ways, which seem almost designed to produce a mishap. Such observations led Spinka et al. (2001) to propose that the original, most basic function of play is what they call “training for the unexpected.” They wrote (p. 143): “We hypothesize that a major ancestral function of play is to rehearse behavioral sequences in which animals lose full control over their locomotion, position, or sensory/spatial input and need to regain these faculties quickly . . . Besides the development of locomotor versatility in unanticipated situations, we hypothesize that animals in play learn how to deal with the emotional aspect of being surprised or temporarily disoriented or disabled.”

Consistent with this theory, many observers have pointed out the apparently dangerous nature of much animal play. For example, Pellis and Pellis (2011) noted that, in play fighting, young animals of many species deliberately put themselves into vulnerable positions, and then struggle to get out of those positions. Others have observed that many young mammals appear to enjoy the thrill and danger of heights and rapid or unusual movements. Examples include goat kids frolicking along cliffs, young chimpanzees dropping from high branches and catching themselves on lower ones before hitting the ground, young macaques swinging on saplings and diving into water, and young polar bears sliding down icy slopes (Aldis, 1975).

Human children, when free to do so, also play in such ways. Groos himself gave examples of children’s play that, he suggested, serve as practice in dealing with surprise and fear, including infants’ enjoyment of “peek-a-boo” and somewhat older children’s enjoyment of fantasy play at fearful themes, such as witches and devils (Groos, 1901, pp. 163–166). More recently, Sandseter (2011) described six categories of risky play that appear to be universal among children: play with great heights, rapid speeds, dangerous tools, dangerous elements (e.g., fire and deep water), rough and tumble, and disappearing/getting lost. Sandseter contends that these are natural ways by which children learn to master fear, both physically and psychologically. One line of evidence supporting this contention derives from research showing that, as children’s freedom to play in risky ways has been declining in recent decades, there has been a dramatic, well-documented increase in anxiety and decline in emotional resilience among children and young adults (Gray, 2011, 2013).

In research designed as a direct test of the training-for-the-unexpected theory, Marks, Vizconde, Gibson, Rodriguez, and Nunes (in press) found that young free-living Belding’s ground squirrels that engaged in more social play showed greater improvement, over time, in their coping ability in novel,

and therefore frightening, test arenas. They showed less fear, explored more, and were quicker to find a hidden escape route back to their natural environment. In another study, Mustoe et al. (2014) found that young marmosets that engaged in more rough-and-tumble play showed reduced cortisol responses (a sign of less distress), over time in repeated stress tests, relative to those that engaged in less such play.

The studies just described are correlational, so we cannot be certain that greater play caused the decline in fear, or decreased fear caused greater play (or both). A number of studies with laboratory-caged rats have tested the effects of play experimentally. In what seems to be the best-controlled such study, Einon et al. (1978) housed young rats in socially isolating cages under three conditions. One condition was total isolation – these were never exposed to other young rats. A second condition involved 1 hour of social contact per day with a normal, playful young rat, during which rough-and-tumble play occurred. A third condition involved 1 hour of social contact per day with a young rat that had been treated with a drug that knocked out rough-and-tumble play but not other social behaviours, such as sniffing and nuzzling. Later, when tested in a novel environment, the animals that had been permitted an hour a day of rough-and-tumble exhibited less fear and more exploration than did those in either of the other two groups.

Other studies have examined the brains of rats that had been allowed rough-and-tumble play compared with those of play-deprived rats (reviewed by Pellis et al., 2014). A repeated finding is that play appears to strengthen neural pathways connecting the prefrontal cortex with emotion-control areas lower in the brain. These brain changes may mediate the effect of play on animals' abilities to modulate their emotions in stressful situations.

### **Play as an Engine of Innovation**

In *Homo Ludens*, Huizinga (1938/1955) argued that human culture arises and advances through play. He contended that the greatest developments in such realms as literature, art, philosophy, and even jurisprudence have occurred at those times and places where a significant number of adults had time and freedom to play. Huizinga stated explicitly in his introduction that his was a cultural theory, not a biological one. Yet it does not take much of a stretch to extend it to become a biological, evolutionary theory.

It seems quite plausible that one evolutionary function of play is to generate, just for fun, novel behaviours and creations, some of which turn out later on to be useful in survival-promoting ways. According to this theory, play, not necessity, is the mother of invention. Necessity generally leads one to try to apply behavioural repertoires or artefacts already available to solve a problem. It takes play, free from necessity, to develop entirely new repertoires and artefacts.

Much psychological research that is not usually described as play research is consistent with this theory. For example, in many experiments, Amabile (1996) showed that people who are asked to make a collage, paint a picture, or create a poem produce more creative and interesting products if they believe they are doing it anonymously, just for fun, than if they are doing it to win a prize or impress a judge. In another set of studies, Isen and her colleagues have shown that people who have been put in a “good mood” – through such means as watching a clip from a slapstick comedy – perform much better in solving insight problems, which require novel ways of thinking, than do people who are given the same problems without that sort of prior experience (e.g., Isen et al., 1987).

On the basis of such research, Fredrikson (2001, 2006) developed what she calls the *broaden-and-build theory of positive emotions*. According to this theory, positive emotions broaden a person’s perception and range of thought, allowing the person to see and think in new ways, thereby building a new repertoire of ideas for possible future use. Concerning play, she wrote: “*Joy*, for instance, creates the urge to play, push the limits, and be creative, urges evident not only in social and physical behavior, but also in intellectual and artistic behavior.” This association of play with creativity is also consistent with the point made earlier in this chapter, that human play is associated with the state of mind referred to as *flow*, a state conducive of creative thinking and innovation.

Although this theory of play’s purpose seems most applicable to humans, it may also apply, at least to some degree, to some other species of primates (Bateson, 2014). In one classic, small-scale experiment, a chimpanzee that had previously had the opportunity to play with sticks figured out how to join sticks together in order to reach a banana that was otherwise out of reach, whereas chimpanzees that had not had such play experience failed to solve that problem (Birch, 1945).

More recent evidence for play’s role in innovation derives from studies of stone play in free-ranging macaque monkeys. Huffman et al. (2008) report that such play consists of “manipulation of stones in various ways, including rubbing or clacking them together, pounding them onto other hard surfaces, picking up and rolling them together in the hands; and cuddling, carrying, pushing, or throwing them.” Such behaviour is passed culturally from generation to generation within the troop, occurring in some troops and not others. In the troop of Japanese macaques that Huffman and his colleagues observed over many years, stone play was first exhibited by a single juvenile female, in 1979. Subsequently, other juveniles, but not adults, began to play in the same ways. As these monkeys grew up, however, many of them continued to play with stones, and then the behaviour was transferred from adults to offspring in subsequent generations.

In this and most other groups of macaques in which stone play has been observed, it appears to be pure play, serving no instrumental function.

However, Tan (2017) has described coastal-living long-tailed macaques that not only play with stones but also use them instrumentally to crack open shellfish. It seems quite plausible that this is a case where monkeys began banging with stones, just for play, but later discovered that they could use that banging to open up shellfish. Stones were initially toys, but then became tools. The same could be said of many human inventions.

### **Play as a Means of Reducing Hostility and Promoting Cooperation**

Social play always requires the voluntary participation of all partners, so it is always an exercise in cooperation and restraint. Players must control their actions so as to avoid hurting or frightening one another. For example, in rough-and-tumble play, which is the most common form of mammalian social play, the larger, stronger, individual must continuously self-handicap, so as not to overwhelm the other.

Marc Bekoff (2001, 2004), who has long studied play in various species of canids, has suggested that animals at play exhibit what we humans consider to be core elements of morality. Play starts with signals that represent an “agreement” to play, not hurt or threaten the other. For dogs, wolves, and other canids, this is the *play bow*, in which each animal crouches down on its forelimbs, with rump and head up, so the back curves down and the neck is exposed – a vulnerable position. For primates, the signal is the *relaxed open mouth display*, also known as the *play face*, which is homologous to playful laughing and smiling in humans. Once play commences, if one animal accidentally hurts the other, such as by nipping too hard, an “apology” is due. That comes through the offending animal’s backing off and, again, manifesting the play signal. “Forgiveness” is manifested when the offended animal, too, reasserts the play signal and play resumes.

Such an analysis suggests that one function of play may be that of enabling animals to form social bonds, which allow them to coexist relatively peacefully and cooperate in life-promoting activities. This theory is supported by evidence that animals that must cooperate for their survival generally play more in adulthood than do other species. For example, adult play is more common among pack-hunting animals, such as wolves, which must cooperate in killing large game, than it is among animals that do not hunt cooperatively (Cordoni, 2009). It may also explain why, among primates, adult social play often involves individuals that know one another but have been separated for a period of time, or a male and female prior to mating (Pellis & Iwaniuk, 2000). In such cases, play may serve to establish or reestablish affiliation, so that subsequent cooperation can occur.

Further support for the cooperation theory comes from research comparing different species of macaque monkeys. All macaques live in colonies that

include both males and females, but species differ from one another in colony organization (Matsumuru, 1999; Thierry, 2000). In some species, most notably Japanese macaques, colonies are steeply hierarchical, such that dominant individuals regularly subjugate and intimidate those who rank lower. At the other end of the spectrum are species – including Tonkean macaques and crested macaques – that live in relatively egalitarian colonies, where dominance hierarchies are muted, fighting is rare, and cooperation is common. Species differences in play may help create or maintain these different ways of living.

In a comparison of Tonkean and Japanese macaques, living in semi-natural conditions, Ciani et al. (2012) found much more play in the former than the latter, among adults as well as juveniles. For adults, however, that difference occurred only for females. Adult female Tonkean macaques played frequently with one another, while adult female Japanese macaques did not play at all, consistent with the idea that, for females, play helps to maintain the cooperative relationships characteristic of Tonkean colonies. Adult males, in contrast, played about equally frequently in the two species. The researchers suggest that, for male macaques, adult play may serve functions beyond that for females. Males, but not females, must leave their natal colony and join a new one when they reach adulthood, so play for them may be a way of establishing new relationships, which may be as crucial for entering a steeply hierarchical society as it is for entering an egalitarian one. For male Japanese macaques, play may be a safe way to test one another's strength and skill, in preparation for future dominance battles.

Other research has revealed different styles of juvenile social play in egalitarian macaque species contrasted with that in Japanese macaques. Young Tonkean and crested macaques commonly wrestle while lying on their sides or backs, in a way that does not resemble serious fighting, and often engage in play with multiple partners, in which they cluster into “writhing masses of bodies” (Reinhart et al., 2010). In contrast, young Japanese macaques almost always play in pairs, in which they adopt defensive postures and play-bite in ways that mimic serious fighting. Such observations suggest that young macaques in the more egalitarian species, in play, practice skills that will enable them to coexist peacefully in close contact, while young Japanese macaques are practicing skills that will facilitate subsequent fighting for dominance.

Other evidence for a relationship between social play and cooperation comes from studies of bonobos. Bonobos are closely related to chimpanzees, but are much more egalitarian and cooperative than are chimpanzees in their social organization, and they are much more playful in adulthood (Palagi, 2008). The most striking characteristic of bonobos, compared with chimpanzees or any other primates, is that the females are generally dominant over males (Parish & de Waal, 2000). This is true even though female bonobos are smaller and weaker than males. They achieve dominance by banding together

and coming to one another's aid in aggressive encounters with males. Their capacity to cooperate in this way, and in many other ways, may be created at least partly through social play. In studies of captive colonies, Palagi (2006; Palagi & Paoli, 2007) found that adult female bonobos engaged in far more rough-and-tumble play with one another than did adult male bonobos. Palagi and her colleagues have also reported that adult bonobos of both sexes appear to use play to prevent conflict in stressful situations. In one study, play was most frequent during the pre-feeding period, when tension would be high in anticipation of competition for food (Palagi et al., 2006). In another study, play signals and non-contact forms of play increased when bonobos were temporarily restricted to crowded indoor quarters (Tacconi & Palagi, 2009).

Elsewhere, with what I have called *the play theory of hunter-gatherer egalitarianism*, I have extended the idea that adult play enables cooperation among humans (Gray, 2014). Anthropologists report regularly that band hunter-gatherer societies are the most egalitarian, non-hierarchical, and highly cooperative societies that have been found anywhere (e.g., Boehm, 1999; Ingold, 1999; Lee, 1988). My analysis of the anthropological literature indicates that they are also the most playful of all societies (Gray, 2009, 2014). Children and even teenagers in such societies are free to play essentially all day, every day. Moreover, and even more telling, all of adult social life in hunter-gather cultures appears to be suffused with play. Their religious practices are playful; their work is conducted in a playful manner; even their manner of settling disputes generally involves humour and play; and their games are playful and cooperative, not competitive. This seems to be true of all band hunter-gatherer societies that have been studied, regardless of which continent they are on and whether they live in rainforests or deserts, or in hot or cold climates.

The hunter-gatherer way of life, everywhere, requires an intense degree of cooperation and sharing, which is incompatible with struggles for dominance. To enable such cooperation, hunter-gatherers had to develop cultural practices that suppress the drive to dominate. Social play is the one category of activity, across mammals, that requires the suppression of dominance. Therefore, I suggest, hunter-gatherers developed ways of turning essentially all of social life into play, which allowed them to share and cooperate more fully than is true of any other primates.

### Concluding Thoughts

Research such as that summarized here makes it clear that play, in its many manifestations, serves a wide variety of survival-promotion functions pertaining to learning, emotional regulation, innovation, and social cooperation. This understanding is especially important, in today's world, because of the ever-increasing restrictions our culture places on children's play,

as children spend ever more time in school and at other adult-directed activities and are prevented, ostensibly for safety reasons, from playing in the free, self-directed, and sometimes risky ways that always characterized children's play in the past. There is good reason to believe that such restrictions are deleterious to children's emotional, social, and intellectual development (Gray, 2011, 2013).

## References

- Aldis, O. (1975). *Play-fighting*. New York: Academic Press.
- Amabile, T. (1996). *Creativity in context: Update to the social psychology of creativity*, Boulder, CO: Westview Press.
- Bateson, P. (2014). Play, playfulness, creativity and innovation. *Animal Behavior and Cognition*, 1, 99–112.
- Bekoff, M. (2001). Social play behavior: Cooperation, fairness, trust, and the evolution of morality. *Journal of Consciousness Studies*, 8, 81–90.
- Bekoff, M. (2004). Wild justice and fair play: Cooperation, forgiveness, and morality in animals. *Biology and Philosophy*, 19, 489–520.
- Bekoff, M., & Byers, J. A. (1981). A critical reanalysis of the ontogeny of mammalian social and locomotor play: An ethological hornet's nest. In K. Immelmann, G. W. Barlow, L. Petrivoch, & M. Main (Eds.), *Behavioral development: The Bielefeld interdisciplinary project*, pp. 296–337. New York: Cambridge University Press.
- Birch, H. G. (1945). The relation of previous experience to insightful problem-solving. *Journal of Comparative Psychology*, 38, 367–383.
- Bloom, L. M., & Lahey, M. (1978). *Language development and language disorders*. New York: Wiley.
- Blumstein, D. T., Chung, L. K., & Smith, J. E. (2013). Early play may predict later dominance relationships in yellow-bellied marmots (*Marmota flaviventris*). *Proceedings of the Royal Society, B. Biological Sciences*, 280, 20130485.
- Bock, J. (2002). Learning, life history, and productivity: Children's lives in the Okavango Delta, Botswana. *Human Nature*, 13, 161–197.
- Boehm, C. (1999). *Hierarchy in the forest: The evolution of egalitarian behavior*. Cambridge, MA: Harvard University Press.
- Boyette, A. H. (2016). Children's play and the integration of social and individual learning: A cultural niche construction perspective. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherer cultures: Evolutionary and ethnographic perspectives*, pp. 159–169. Tokyo: Springer Japan.
- Burghardt, C. (2005). *The genesis of animal play: Testing the limits*. Cambridge, MA: MIT Press.
- Byers, J. A. (1998). Biological effects of locomotor play: : Getting into shape, or something more specific? In M. Bekoff & J. A. Byers (Eds.), *Animal play: Evolutionary, comparative, and ecological perspectives*, pp. 205–220. Cambridge: Cambridge University Press.
- Byers, J. A., & Walker, C. (1995). Refining the motor training hypothesis for the evolution of play. *The American Naturalist*, 146, 25–40.

- Ciani, F., Dall'Olio, S., Stanyon, R., & Palagi, E. (2012). Social tolerance and adult play in macaque societies: A comparison with different human cultures. *Animal Behaviour*, *84*, 1313–1322.
- Cordoni, G. (2009). Social play in captive wolves (*Canis lupus*): Not only an immature affair. *Behaviour*, *146*, 1363–1385.
- Csikszentmihalyi, M. (1975a). *Beyond boredom and anxiety: The experience of play in work and games*. San Francisco, CA: Jossey-Bass.
- Csikszentmihalyi, M. (1975b). Play and intrinsic rewards. *Journal of Humanistic Psychology*, *15*, 41–63.
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper & Row.
- Einon, D., Morgan, M. J., & Kibbler, C. C. (1978). Brief periods of socialization and later behavior in the rat. *Developmental Psychobiology*, *11*, 213–225.
- Fagen, R. A., & Fagen, J. (2009). Play behavior and multi-year survival in free-ranging brown bears, *Ursus arctos*. *Evolutionary Ecology Research*, *11*, 1053–1067.
- Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, *56*, 218–226.
- Fredrickson, B. L. (2006). The broaden-and-build theory of positive emotions. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), *A life worth living: Contributions to positive psychology* (pp. 85–103). Oxford: Oxford University Press.
- Fry, D. P. (1992). “Respect for the rights of others is peace”: Learning aggression versus nonaggression among the Zapotec. *American Anthropologist*, *94*, 621–639.
- Gomendio, M. (1988). The development of different types of play in gazelles: Implications for the nature and functions of play. *Animal Behavior*, *36*, 825–836.
- Gray, P. (2009). Play as the foundation for hunter-gatherer social existence. *American Journal of Play*, *1*, 476–522.
- Gray, P. (2011). The decline of play and the rise of psychopathology in childhood and adolescence. *American Journal of Play*, *3*, 443–463.
- Gray, P. (2012a). Peter Gray. Definition of play. In *Encyclopedia of play science*. Available at [www.scholarpedia.org/article/Encyclopedia\\_of\\_Play\\_Science](http://www.scholarpedia.org/article/Encyclopedia_of_Play_Science).
- Gray, P. (2012b). The value of a play-filled childhood in development of the hunter-gatherer individual. In D. Narvaez, J. Panksepp, A. Schore, & T. Gleason (Eds.), *Evolution, early experience and human development: From research to practice and policy* (pp. 352–370). New York: Oxford University Press.
- Gray, P. (2013). *Free to learn: Why unleashing the instinct to play will make our children happier, more self-reliant, and better students for life*. New York: Basic Books.
- Gray, P. (2014). The play theory of hunter-gatherer egalitarianism. In D. Narvaez, K. Valentino, A. Fuentes, J. McKenna, & P. Gray (Eds.), *Ancestral landscapes in human evolution: Culture, childrearing and social wellbeing* (pp. 190–213). New York: Oxford University Press.
- Gray, P. (2016a). Children’s natural ways of learning still work – Even for the three Rs. In D. C. Geary & D. B. Berch (Eds.), *Evolutionary perspectives on child development and education* (pp. 63–93). New York: Springer.

- Gray, P. (2016b). Mother Nature's pedagogy: How children educate themselves. In H. Lees & N. Noddings (Eds.), *Palgrave international handbook of alternative education* (pp. 49–62). London: Palgrave.
- Groos, K. (1898). *The play of animals*. New York: Appleton.
- Groos, K. (1901). *The play of man*. New York: Appleton.
- Huffman, M. A., Nahallage, C. A. D., & Leca, J.-B. (2008). Cultured monkeys: Social learning cast in stones. *Current Directions in Psychological Science*, *17*, 410–414.
- Huizinga, J. (1938/1955). *Homo ludens: A study of the play-element in culture*. Boston: Beacon.
- Ingold, T. (1999). On the social relations of the hunter-gatherer band. In R. B. Lee & R. H. Daly (Eds.), *The Cambridge encyclopedia of hunters and gatherers* (pp. 399–410). Cambridge: Cambridge University Press.
- Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, *52*, 1122–1131.
- Kahlenberg, S. M., & Wrangham, R. W. (2010). Sex differences in chimpanzees' use of sticks as play objects resemble those of children. *Current Biology*, *20*, R1067–R1068.
- Kuczaj, S. A. (1985). Language play. *Early Child Development and Care*, *19*, 53–67.
- Lancy, D. F. (2016). Teaching: Natural or cultural? In D. C. Geary & D. B. Berch (Eds.), *Evolutionary perspectives on child development and education* (pp. 63–93). New York: Springer.
- Lee, R. B. (1988). Reflections on primitive communism. In T. Ingold, D. Riches, & J. Woodburn (Eds.), *Hunters and gatherers 1*. Oxford: Berg.
- Marks, K. A., Vizconde, D. L., Gibson, E. S., Rodriguez, J. R., & Nunes, S. (in press). Play behavior and responses to novel situations in juvenile ground squirrels. *Journal of Mammalogy*.
- Matsumura, S. (1999). The evolution of “egalitarian” and “despotic” social systems among macaques. *Primates*, *40*, 23–31.
- Meaney, M. J., Stewart, J., & Beatty, W. W. (1985). Sex differences in social play: The socialization of sex roles. *Advances in the Study of Behavior*, *15*, 1–58.
- Miller, N. (1973). Ends, means, and galumphing: Some leitmotifs of play. *American Anthropologist*, *75*, 87–98.
- Mustoe, A. C., Taylor, J. H., Birnie, A. K., Huffman, M. C., & French, J. A. (2014). Gestational cortisol and social play shapes development of marmosets' HPA functioning and behavioral responses to stressors. *Developmental Psychobiology*, *56*, 1229–1243.
- Nunes, S. (2014). Juvenile social play and yearling behavior and reproductive success in female Belding's ground squirrels. *Journal of Ethology*, *32*, 145–153.
- Palagi, E. (2006). Social play in bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*): Implications for natural social systems and interindividual relationships. *American Journal of Physical Anthropology*, *129*, 415–426.
- Palagi, E. (2008). Sharing the motivation to play: The use of signals in adult bonobos. *Animal Behaviour*, *75*, 887–896.
- Palagi, E., & Paoli, T. (2007). Play in adult bonobos (*Pan paniscus*): Modality and potential meaning. *American Journal of Physical Anthropology* *134*, 219–225.

- Palagi, E., Paoli, T., & Tarli, S. B. (2006). Short-term benefits of play behavior and conflict prevention in *Pan paniscus*. *International Journal of Primatology*, *27*, 1257–1269.
- Parish, A. R., & de Waal, F. B. (2000). The other “closest living relative”: How bonobos (*Pan paniscus*) challenge traditional assumptions about females, dominance, intra- and intersexual interactions, and hominid evolution. *Annals of the New York Academy of Sciences*, *907*, 96–113.
- Pellis, S. M., & Burghardt, G. M. (2017). Play and exploration. In J. Call (Ed.), *APA handbook of comparative psychology* (pp. 699–722). Washington, DC: American Psychological Association.
- Pellis, S. M., & Iwaniuk, A. N. (2000). Adult–adult play in primates: Comparative analysis of its origin, distribution and evolution. *Ethology*, *106*, 1083–1104.
- Pellis, S. M., & Pellis, V. C. (2011). Rough and tumble play: Training and using the social brain. In A. D. Pellegrini (Ed.), *The Oxford handbook of the development of play* (pp. 245–259). New York: Oxford University Press.
- Pellis, S. M., Pellis, V. C., & Himmler, B. T. (2014). How play makes for a more adaptable brain: A comparative and neural perspective. *American Journal of Play*, *7*, 73–98.
- Reinhart, C. J., Pellis, V. C., Thierry, B., Gauthier, C.-A., VanderLaan, D. P., Vasey, P. L., & Pellis, S. M. (2010). Targets and tactics of play fighting: Competitive versus cooperative styles of play in Japanese and Tonkean macaques. *International Journal of Comparative Psychology*, *23*, 166–200.
- Sandseter, E. (2011). Children’s risky play from an evolutionary perspective: The anti-phobic effects of thrilling experiences. *Evolutionary Psychology*, *9*, 257–284.
- Spinka, M., Newberry, R. C., & Bekoff, M. (2001). Mammalian play: Training for the unexpected. *Quarterly Review of Biology*, *76*, 141–168.
- Tacconi, G., & Palagi, E. (2009) Play behavioural tactics under space reduction: Social challenges in bonobos, *Pan paniscus*. *Animal Behaviour*, *78*, 469–476.
- Tan, A. W. Y. (2017). From play to proficiency: The ontogeny of stone-tool use in coastal-foraging long-tailed macaques (*Macaca fascicularis*) from a comparative perception-action perspective. *Journal of Comparative Psychology*. Advance online publication, <http://dx.doi.org/10.1037/com0000068>.
- Thierry, B. (2000). Covariation and conflict management patterns across macaque species. In F. Aureli & F. B. M. de Waal (Eds.), *Natural conflict resolution*, pp. 106–128. Berkeley: University of California Press.
- Vygotsky, L. S. (1978). The role of play in development. In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.), *Mind in society: The development of higher psychological processes*, pp. 92–104. Cambridge, MA: Harvard University Press.