The Comparative Reach of Play and Brain

Perspective, Evidence, and Implications

Gordon M. Burghardt

Scholars interested in play in humans should take note of the growing literature on play in other species, especially in light of the application of evolutionary approaches to virtually all areas of psychology. Although most research on animal play deals with mammals—particularly rodents, carnivores, and primates—studies have recorded play of different types in a wide range of other animals, both vertebrate and even invertebrate, who differ greatly in their ecology, their behavior, and their nervous systems. How we characterize such diverse forms of play shapes how we pose research questions and evaluate evidence about play in all species, including humans. In this article, the author reviews the research about play across major taxonomic divisions and looks at the questions that arise when anthropocentric views of play are set aside in order to understand play more broadly. The author then considers how this knowledge illuminates the diversity of play among humans, whom he sees as on the edge of evolutionary change. The article concludes that an understanding of the evolutionary and comparative diversity of play may have implications for integrating play into education and into other attempts to solve ills in society.

Introduction

The study of play in both human and nonhuman species has grown rapidly in the last few years. The increased interest in play reflects a growing concern in educational circles about what children are learning in school, about a lack of exercise and attendant health and obesity issues, and about the ever more narrow interaction of children with the natural world (and, therefore, their loss of affection for it, especially as environmental challenges grow more pressing). Is the changing nature of play in our society at all involved in these developments? In the face of these developments, many see in play an untapped source of renewal physically, mentally, and spiritually. But the problems facing those

of us studying and advocating play are complex, and one solution may conflict or even preclude another. Those primarily interested in play in humans, especially children and adolescents, may find it helpful to consider the lessons, both encouraging and cautionary, already learned by researchers who have worked on comparative animal play and in the neuroscience related to it.

Play has been recognized in nonhuman animals (hereafter just animals) for many centuries, but the study of animal play, like so much animal behavior, really

Figure 1. A depiction of the diverse kinds of play in children of various ages from Catz (1655, p. 4). All three major categories of play identified in animals (locomotor, object, and social) are seen here in multiple forms and combinations (source: Gordon M. Burghardt, personal collection).

did not develop until after the writings of Charles Darwin and the rise of natural history, comparative psychology, and, in the early twentieth century, ethology. For our purposes, play in animals means solitary (or parallel) locomotor-rotational play (jumping, leaping, twisting, swinging, running), object play (carrying, dropping, manipulating, biting, mouthing), and social play (chasing, wrestling). These kinds of play are not completely independent, and all three can occur at the same time—when, for example, two dogs chase after a stick, both grab it, and they proceed to engage in a tug-of-war for possession. Of course, many additional kinds of play have been described in humans, especially those labeled sociodramatic play, pretense, construction play, games, language play, and babbling.

Here I will summarize and update some of the comparative data presented in my book on animal play (Burghardt 2005; see also Burghardt, forthcoming), develop some themes, and embed these views in evolutionary psychology—resurgent in recent years and especially so as I wrote most of this article in the month (November 2009) of the 150th anniversary of Charles Darwin's *On the Origin of Species*. The anniversary was commemorated in many venues, even in *American Psychologist*, the journal of the American Psychological Association, which offered a special issue devoted to Darwin's contributions to psychology (Dewsbury 2009). But play as a topic has not been at the forefront of evolutionary thinking. Yet, if animal play has any implications for those who focus on play in *Homo sapiens*, an evolutionary approach needs to be taken seriously.

Evolutionary Psychology, Ecology, and the Problem of Play

The typical approach to play for many researchers begins with a fascination with the play of children, something all of us are familiar with personally and which harks back to an often more carefree time in our lives. Furthermore, there is something endearing and enduring about play in childhood in all its diversity, which seems threatened today with computer games, interactive TV, indirect social encounters over the Internet, and the incessant interruptions of cell phone calls and texting. This nostalgia, which may nonetheless be critically important, is represented in a wonderful 1655 engraving from Jacob Catz (figure 1). Like the famous painting on children's play by Pieter Bruegel, this engraving depicts numerous playful activities spanning the range of the three categories of play in animals: locomotor/rotational play, play with objects, and social play. This figure

depicts jumping rope, flying kites, walking on stilts, bowling, playing leapfrog, marching in a band, riding on a hobby horse, playing blind man's bluff, and, in the lower left corner, playing with dolls and kitchen implements. Catz depicts numerous other types of interactive play and, appropriately enough for this article, near both the left and right margins, he includes dogs at play as well.

The myriad richness of play captured by Catz has led to a fascination with the details of specific play activities which, while obviously important, obscure the commonalities of all forms of both human and animal play. Much of the recent work on animal play, including articles in this issue of the *American Journal of Play*, identifies and discusses some of these possible commonalities. Here, I hope to provide a framework for such study.

Consider first, evolution. Evolutionary psychology is now a popular field sparking much student interest and boasting a growing number of courses, texts, books, and monographs, not to mention journals and societies. In its most basic formulation, evolutionary psychology involves the application of Darwinian principles to psychological and behavioral phenomena in humans. Specifically, it rests on four assumptions. The first is that much of human behavior contains features inherited from our vertebrate ancestors. Thus, nonhuman primate studies are often used in searching for commonalities and differences between humans and animals.

The second assumption posits that much of our psychology evolved to deal with the recurrent demands of finding food, mating, protecting ourselves from predators and enemies, rearing offspring, and living in social groups. This assumption reflects the ethological emphasis on embedding the study of behavior, human and nonhuman, in the natural world where the social and ecological contexts of such behavior are and have been shaped by natural selection and other evolutionary processes.

The third suggests that psychology involves neural, perceptual, behavioral, learning, and emotional systems that are modular rather than general-purpose mechanisms. Unlike general-purpose mechanisms, modular systems are not easily altered by the application of a few principles or techniques. The classic example is someone who seems better able to learn about social cheating than about the equivalent problem in a more abstract context. Other examples include the ease with which certain fears are acquired or the specializations underlying learning a new language.

A fourth implication assumes that humans everywhere are more similar than different due to a common human nature that transcends culturally im-

posed differences. This becomes apparent when play researchers emphasize the different kinds of games and play activities engaged in across cultures and through historical time (Clements and Fiorentino 2004; Carlisle 2009). The great familiarity in Western cultures, at least, with the forms of play seen in Holland over 350 years ago, is sufficient support for this fourth assertion.

There is a danger in adopting an evolutionary approach that emphasizes the value and function of play instead of the biological processes underlying play, including the neurological ones. It is easier to avoid a full—and necessary—familiarity with modern evolutionary science. Thus, many in the first wave of evolutionary psychologists seemed only minimally conversant, even uninterested in, either pattern (that is, evolutionary phylogenetic relationships) or process (meaning the mechanisms of evolutionary change and how they operate at different levels). As Panksepp and Panksepp (2000) have documented, specialists often downplayed the findings of comparative psychology, ethology, neuroscience, and behavioral development and discounted the role of our ancient vertebrate behavioral legacy, although they grudgingly accepted possible links to the psychology of apes and other primates. And too often they focused on the speculative legacy of the role of natural selection—especially its sexual aspects—in shaping the behavior of protohominids and early humans in the millennia before the advent of literacy and agriculture. Early evolutionary psychologists simply adapted traditional psychological survey methods to different ends and downplayed the ethological observation of people and animals. Thus, they largely ignored play. Even today, students will find play barely mentioned in the major textbooks or current research programs. But among a growing number of those in the field, there is now an increased awareness of the need to compare apes and humans, at least in terms of social play (e.g., Lewis 2005 and other chapters in Pellegrini and Smith 2005).

On the surface, ignoring play seems so odd a thing to do because it is so ubiquitous. Play (and recreation in general) serves a major goal and motivation for most people. In humans and other species, it can consume large amounts of time and energy. Indeed, human beings and other animals often play much more frequently than they fight, have sex, and even eat. One reason for the relative neglect of play in evolutionary science is that play appears to lack seriousness either in its proximal manifestations or in its adaptive value or function. Perhaps scientists, including evolutionary psychologists and neuroscientists, viewed play both theoretically and unconsciously as a nonserious topic and thus as unimportant to the study of both evolution and the brain. Indeed, as

Jaak Panksepp has pointed out, it was often (and sometimes still is) difficult to publish in neuroscience journals using terms such as play and laughter (J. Panksepp, this issue, pers. comm.). On the other hand, there may now be a need for those studying play in humans to view their work in a modern evolutionary and neuroscience context and view this approach as relevant for their agendas. There are signs that this is happening now on several fronts.

Evolutionary processes take place in ecological settings, and consideration of such settings can be as important as the evolutionary results. As I suggested earlier, the ecological setting in which play occurs in humans in economically developed cultures seems to have been changing rapidly in the last several decades, and the consequences of this change are not yet evident. In the Catz engraving, it is noteworthy that all the play takes place outdoors. Almost all of it is physically active play. And even the object and locomotor play activities take place in social contexts. The Catz engraving certainly calls to mind the free-play recess periods most of us had in school. Note that other than playing in the band, which has an older leader, none of the activities seems to be highly organized. We see no supervising counselors, no coaches, no one teaching a set of skills, or trying to ensure equitable access for everybody present. The play of the engraving looks spontaneous, seemingly a natural outgrowth of past interests, and is based on skills children have already acquired. Certainly this engraving is idealized, and it depicts no actual playground. But it does remind us that the best and most memorable play events may be those informally supported simply by providing safe outdoor spaces.

What is Play and Who Plays?

Some early nineteenth-century authorities claimed that play occurred in a wide variety of animals—even crabs, ants, and fish (see my review in Burghardt 2005). Even Darwin favorably discussed play in ants. However, all these reports relied on anecdotal evidence in the days before film and video documentation. By the 1920s, play largely became the provenance of humans and other "intelligent" mammals such as monkeys, apes, dogs, and cats. Furthermore, by early in the twentieth century, many scientists, especially psychologists, viewed play as existing primarily in order to help animals learn how to survive when they became adults. Indeed, Karl Groos (1898) thought play a necessary means for animals to develop and perfect their instinctive behavior (finding

food, fighting conspecifics, repulsing predators, courting and mating, and building nests). His view became the major theoretical assumption, although it had many variants. Many who made this assumption believed also that the benefits of play were delayed until adulthood. Although play may appear to be fun or enjoyable for its own sake, they argued, these features were not what was important about play. The confusion caused by such thinking echoes in present-day demands for educational toys, for example.

Others saw play as something other than simple practice for the future. The Freudians (Winnicott 1971), for example, viewed play as a means to deal with troubling, if not traumatic, events. This view, which has led to a major focus in play therapy (Gitlin-Weiner, Sangrund, and Schaefer 2000), does not seem to have much traction in the animal play literature except for observations that opportunities to play may alleviate stimulus deprivation, boredom, self-mutilation, and susceptibility to disease in animals (Burghardt, et al. 1996). Claims that play is linked to intelligence, large brains, and prolonged parental care seemed to support the practice-delayed-benefit views. Many thought that true play was most common, if not exclusively found, in higher mammals. The playlike behavior of other species was largely dismissed as misidentified or misfiring instincts, or fragments of maturational processes. Even accepting that bird play was suspect to many authorities as late as the 1980s. Robert Fagen, who, in his seminal volume on the biology of animal play (Fagen 1981), concluded that some birds certainly did play, remained skeptical of play in cold-blooded vertebrates and invertebrate species. He did advocate the view that play may have immediate benefits for animals, not just benefits later in adulthood for the serious tasks in life. For example, Fagen argued that juvenile play is important for the development of muscles, for coordination, and for physiological performance in general. The problem remained, however, that few of these benefits, immediate or delayed, could be empirically confirmed with careful experimentation in either human or nonhuman animals of any species (Martin and Caro 1985). Some questioned whether perhaps the meaning of play lay elsewhere than in a stark utilitarianism or obvious functionalism (Burghardt 1984). Maybe there was more to it than that play fighting leads to better fighting, play by cats with objects leads to better hunting ability, play with dolls leads to better mothering, and so on. Today, progress is finally being made on the neurological processes and consequences of social play in mammals, but it took a more detailed behavioral analysis of play, some imaginative experimental designs, recent advances in neuroscience, and less simplistic functional hypotheses to get here (Pellis and Pellis 2009).

But in most discussions up to the last decade, a more fundamental problem plagued a comprehensive comparative understanding of play. A careful analysis of the literature of play in animals uncovered no clear criteria for identifying play from nonplay behavior. All the proposed definitions of animal play were to varying extents vague, anthropomorphic, and limited to only certain categories of play. Although the child-behavior literature was often more systematic, it boasted no shared and accepted definition that clearly and objectively marked off play as a phenomenon. Indeed, there remains much ambiguity about what constitutes human play beyond childhood (Sutton-Smith 1997). How, then, can one identify play in species and in contexts where it has not been thought to exist? This difficult question cannot be avoided if we want to measure the comparative reach of play.

Even the play we think we recognize in our pets is problematic. We may all agree that we have seen, say, a dog or a monkey play, but it turns out that we only do so because we anthropomorphize their behavior and its underlying emotion. They are playing because they act and seem to feel like we do when we play. But what about play in birds, turtles, fish, frogs, and insects, where it is much harder to be empathic? If we want to determine how ancient and basal play is in human behavior and psychology, it is imperative that we find out whether play is, like endothermy or enlarged frontal lobes, a recent evolutionary innovation, as championed by some writers, or whether it also occurs in much older, more primitive animals.

To help answer such questions, I developed a set of five criteria, all of which must be met, in at least one respect, before we can confidently assume a behavior is play. I have provided more explication and additional examples for these criteria in *The Genesis of Animal Play* (2005) and in an entry on play I wrote for *Encyclopedia of Animal Behavior* (forthcoming). First among the five criteria is that in play the performance of the behavior is not fully functional in the form or context in which it is expressed; that is, it includes elements, or is directed toward stimuli, that do not contribute to current survival. Second, play behavior is spontaneous, voluntary, intentional, pleasurable, rewarding, reinforcing, or autotelic (done for its own sake). Third, play differs from more serious performance of ethotypic behavior structurally or temporally in at least one respect: it is incomplete (generally through inhibited or dropped final elements), exaggerated, awkward, or precocious; or it involves behavior patterns with modified form, sequencing, or targeting. Fourth, play is behavior performed repeatedly in a similar, but not rigidly stereotyped, form during at least a portion of an animal's ontogeny. And fifth and last, play is initiated when an animal is ad-

equately fed, healthy, and free from acute or chronic stress (starvation, predator threat, harsh microclimate, social instability) and intense levels of competing behavioral systems (foraging, mating, and predator avoidance), although mild stress, including boredom and social deprivation, may facilitate play.

These all can be summarized in a sentence: 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. Saying that play is initiated voluntarily could mean that it involves pleasure, fun, excitement, rewards, or other emotional attributes, of course, but these are not explicitly included in the criteria since they may be hard to ascertain in animals we are less prone to view as similar to us, animals such as turtles or fish.

With this set of criteria as a tool, we can see that much of our behavior—from gourmet cooking to doodling—can be viewed as play. And so can the more physical activities so prominent in the play of animals and young children. For example, learning to walk in infants can clearly be considered play using these five criteria. More importantly, applying the criteria allows us to see play in the behavior of many animals other than birds and placental mammals. Let me share a few examples. Play has been found in many but not all placental mammals. In some orders of mammals, play of all three types is common. Many marsupials such as kangaroos, wallabies, Tasmanian devils, and wombats are playful, though as a group they have nowhere near the rich playfulness one sees in dogs, monkeys, and otters. Even the archaic egg-laying monotreme mammal, the duck-billed platypus, appears to engage in social play (Burghardt, 2005; Siviy, pers. comm.). Since both placental and marsupial animals have diversified into families and genera that have similar ecological niches, there is an opportunity to compare the play in these two independent radiations. Play in birds is widespread, though also not as ubiquitous as in placental mammals. Here too, phylogeny opens up opportunities for comparative analysis (Diamond and Bond 2003). Some birds, especially parrots such as keas and passerines such as ravens, play in ways much more complex than found in most mammals.

Current data strongly suggest that some animals from many other groups, including fishes, insects, mollusks, and reptiles can and do play according to the criteria. We studied the first Komodo dragon hatched in the Western world at the National Zoo in Washington, DC. This monitor species is the largest lizard in the world and is a deadly carnivore, capable of hunting, killing, and eating deer and water buffalo. This lizard, when several years old, would explore objects such as old shoes, small boxes, even soft drink cans and grab and shake

them like a dog with a slipper. And like the dog, the lizard would not try to eat the object. She would also engage in a tug-of-war with her favored keeper and remove handkerchiefs or notebooks from a keeper's pocket and try to keep them. For many years, a large adult aquatic turtle at the same zoo would bang a basketball around his tank. A large saltwater crocodile repeatedly chased and attacked a large ball attached to a rope thrown around and pulled by a keeper outside his large, naturalistic enclosure. Great white sharks will do something similar. Several species of fish push around balls and balance sticks on their snouts. A cichlid fish will engage in behavior with a larger less agile fish that looks, objectively, like something we would call teasing if we saw it in kids or even dogs. Play fighting is the best-studied type of play in animals and is the focus of literally hundreds of experiments with laboratory rats. Comparable documented observations of social play have been made of dart poison frogs, young turtles, some bony fishes, and elasmobranches (Burghardt 2005). Among the latter, freshwater stingrays are so attracted to balls that sink to the substrate that two of the creatures will engage in a game of keep-away. A phylogeny of play in the major groups of vertebrates is depicted in figure 2.

Among invertebrates, the best-studied species are octopuses, which have been documented performing complex manipulations with LEGO blocks and using their water jet abilities to repeatedly bounce floating balls. Crustaceans seem to engage in object play. Honeybees practice take offs before their first successful flights. These and similar observations have been gathered in Burghardt (2005). Since then, additional examples have appeared. Using the five play criteria, Dapporto, Turillazzi, and Palagi (2006) documented brief bouts of play fighting in female wasps in the months before they compete seriously for territories. As diverse as these examples are, it is important to note that most species in these and other groups have not been recorded at play, nor do they all play in the same way or to the same extent.

The Origins of Play

While the social, locomotor, and object play I have described in animals are all common in humans and other primates, other types of human play, such as construction, social-dramatic, language, pretense, and games are more commonly studied. But with these also, rudimentary versions may all be found in other species as well. From an evolutionary perspective, play appears to have originated numerous times in animals throughout their evolutionary history

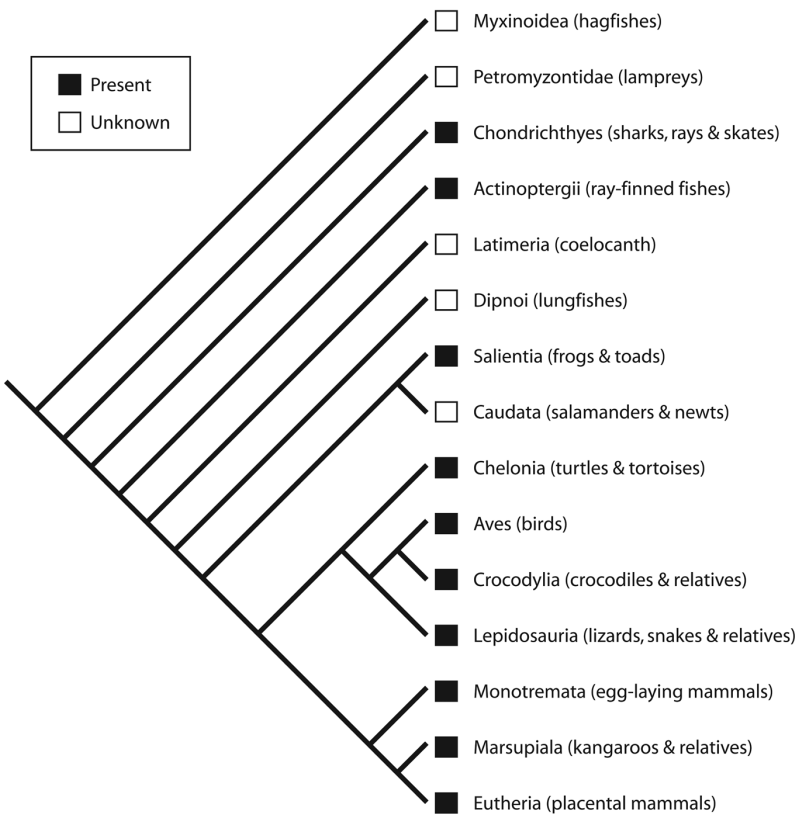

Figure 2. A phylogeny of play in which there is convincing evidence for play in at least one species in each of the represented taxonomic units (expanded and updated version of Figure 15.1 in Burghardt 2005).

and has altered course in many ways, even in the most playful mammals. Thus, adult play in monkeys can differ in type and amount dramatically even in closely related species (Pellis and Iwaniuk 2000). Furthermore, sex differences are pronounced in many species and these may themselves be related to evolutionary history and behavioral ecology—including mating systems, foraging and fighting modes, type of predators and other dangers, and amount and extent of parental care and protection. If these more complex kinds of play have derived from the more elementary ones most frequently found in other species, then, knowledge of the course of the evolution of play and its underlying causes may help us more effectively reincorporate play into modern life. Indeed, a play ecology satisfactory for human needs must take into account much of the basic, evolved psychology of our species. Increasing evidence, including work in neuroscience, shows that

play taps into ancient behavioral, brain, and neurotransmitter systems found in many species. By exploring the diverse manifestations of play in other species, we may derive useful insights about play in our own. An important starting point for such study is to recognize that play, in all its diversity, is a phenomenon identified by a set of criteria and not an unitary category, does not have a single evolutionary origin or history, and cannot be considered to have a single function or even, perhaps, any function at all. This, of course, in relation to human play, was the implicit, if not explicit, message of Sutton-Smith's seminal volume *The Ambiguity of Play* (1997), a book that greatly inspired and directed my thinking on animal play.

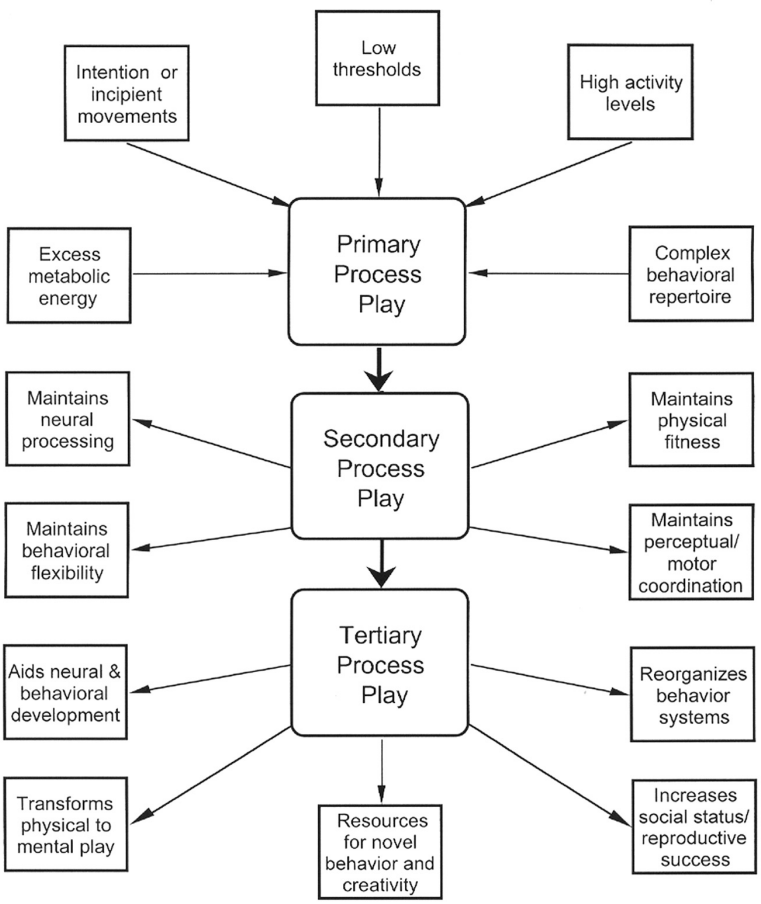

Figure 3. Attributes and consequences of primary-, secondary-, and tertiary-play processes (reprinted from Figure 5.1 in Burghardt 2005).

Thus, comparative studies teach us that the importance of play and its role in an animal's life and development may differ greatly, even at the simple level of its causal mechanisms and developmental consequences. Such differences can even occur in the same species—human play ranges from the highly creative to the most banal and even destructive. It is useful to categorize the initiating factors and consequences of play into three process levels (figure 3), although in reality a continuum certainly exists. Thus, we can have *primary-process play* that is somewhat atavistic and grows out of boredom, low behavioral thresholds, immature behavior, excess metabolic energy, and other factors with no necessary long-term effects, good or ill. We can have *secondary-process play* that helps maintain the condition of the animal physiologically, behaviorally, and perceptually. For example, physical exercise may be necessary for maintaining cardiovascular functioning and body flexibility, and mental games may aid in slowing the effects of senile dementia. Finally there is *tertiary-process play* that may be crucial for reaching developmental milestones, cognitive accomplishments, social skills, and physical abilities. (These three terms have been used somewhat differently in other formulations. For example, primary process can refer to subcortical brain mechanisms underlying innate emotions; secondary process, to learned emotions; and tertiary process, to episodic memories and symbolic thought [Panksepp 2009]. My formulation is based on the varying roles play can play in the lives of animals.)

In humans, all three levels of play can occur, even co-occur, but so far we do not know which play in human or nonhuman animals rightfully falls under which rubric and at which times in life. Nor do we know what specific consequences there are to different kinds of play. Do play fighting and competitive games foster war and aggression or a sense of fairness and the necessity of following rules? There are strong advocates on both sides of this issue. While the fairness issue is now gaining traction in animal research (Pellis and Pellis 2009; Bekoff and Pierce 2009), there is also renewed concern about the aggression-inducing effects of violent video games, sports, and entertainment. While such questions may not be easy to answer and may press ideological buttons, play researchers need to keep an open mind on the differing adaptive consequences of play in all its manifestations.

The conceptual framework I have outlined suggests that we look for the factors in both the environment and the organism that facilitate the performance of play. Some kinds of play are more individually or socially adaptive than others. Thus we must not forget that hazing, bullying, cruelty, gambling,

risk taking, compulsions, and addictions of many kinds can have their origins in play. Ironically, it was my work on reptiles, which did not seem to play much if at all, that led me to the ideas underlying Surplus Resource Theory (SRT) (Burghardt 1984). Reptiles, lacking parental care, must largely survive on their own with little parental guidance providing them with nutrition, protection, and time to engage in behavior not directed towards immediate ends. Furthermore, reptiles have a physiology that is generally not conducive to the sustained vigorous behavior often seen in play. Reptiles also do not possess the rich behavioral repertoire of limb, body, facial, and other body parts of many mammals, and usually they operate on slower time scales, having a metabolic rate averaging only 10 percent that of the typical mammal. Still, as noted above, some reptiles do play, as do fish and other "lower" animals. By examining those that do and do not play and also by looking at the great extent of play diversity in mammals and birds, we see that several major groups of factors underlie the surplus resources that allow animals to play, that is, to engage in behavior not totally needed for current survival demands.

I do not have room to discuss all the details underlying the integrative SRT perspective at length here (Burghardt 1984, 2005), but some of the biological factors facilitating play are good health, a physiology conducive to vigorous and sustained activity, and a diet that can sustain such behavior. Developmental factors such as having parental care allowing the animal to explore and play in relative safety and a sufficient time to do this are also important. Species possessing a rich repertoire of instinctive behavior patterns and motivational and emotional resources seem to play more complexly. Ecological factors such as weather, potentially dangerous environments (trees, water, predators), and foraging styles along with social factors such as type and number of potential play partners and social openness or rigidity affect play in other species and certainly do so in people. Individual differences in play propensity and skills are found in humans and nonhumans alike. Such differences provide the raw variation needed for natural selection, including sexual selection, to operate its transformative magic.

I have discussed primarily play in its behavioral manifestations. These are most easily studied in humans, especially young children, and other animals. But much of our play may be performed without overt behavior. We play with ideas; we imagine scenarios or creative outcomes prior to, or even without, actual performance. Just as gestures, so common during human speaking, suggest that gestures were prior to vocal communication, so may behavioral play be the essential precursor to mental play and, by implication, be a major force

in the evolution of human cognitive and emotional abilities. It is possible that primary-process play that initially had no adaptive consequences became useful to the individual and was transformed via selection to serve both secondary and tertiary functions in development and reproductive fitness as well as to provide variation from which novel and complex behavior could develop more rapidly than through selection of the more fixed functional aspects of an animal's behavior. In this way, the cognitive and emotional life of animals, especially people, was pried open and transported to new adaptive peaks. If so, then the analysis of play and its origins may prove crucial to understanding the evolution of human mentality and should be a central, not a peripheral, subject in evolutionary psychology, as well as in child development (Mitchell 2002).

Towards an Integration of Comparative Behavior Studies and Practice

Evolutionary and ecological considerations, along with studies of the brain and play, help explain why some species play and others play less so or not at all. They may also explain variation in play within the same species. But what are the lessons of this comparative knowledge for encouraging useful play in human children and adults? Some lessons are based on common sense, and much research seems straightforward (Johnson, Christie, and Yawkey 1999; Power 2000; Pelligrini 2009; Singer, Golnikoff, and Hirsh-Pasek 2006). Children will play more if they are healthy, have good diets, feel (and are) safe, and have the prior experiences (social, motor, etc.) to engage in diverse and innovative play rather than in repetitive and prosaic behavior. Rich environments with objects and social partners that encourage open-ended activities of various types may be more successful than elaborate facilities devoted to a single sport. Studies have shown that the same environments may elicit different kinds of physical and imaginative play depending on gender, social class, and parental involvement and support for play (which includes reading books and allowing children to mess up their environments and to develop their own games with found objects). Such approaches can also be applied in using play to foster activities and rehabilitation of the brain injured, the long-term ill, or the elderly.

Playworkers (a wonderful professionalized occupation dealing with all kinds of populations in Great Britain) also need to be attuned to what is really play, especially social play involving several children, and to how children play in unexpected ways with equipment designed for different purposes. Thus free

play should be encouraged, which is hard in an era of increasingly structured and adult-directed, "appropriate" play. Some of the pressures to control play are certainly legitimate, but, undeniably, the changes in the nature of play in the United States have been dramatic (Hofferth, Sandberg 2001a, 2001b). Yet, increasingly, studies document the value of recess for children in schools (Barros, Silver, and Stein 2009; Pelligrini 2009).

Another feature of play is that it may serve to arouse strong, biologically centered emotions in a safe or controlled environment. Amusement rides such as roller coasters and the more risky organized sports such as whitewater kayaking and rock climbing may stimulate, as Sutton-Smith has described them, "virtual" emotions of fear and relief commonly experienced by all people in the past, but which are often missing in our lives these days, buffered as they are from more primal survival risks. The stimulating argument that much physical play in animals is "training for the unexpected" (Špinka, Newbury, and Bekoff 2001) supports this possibility. The playful aspects of infants learning to walk suggest the value of controlled risks in acquiring major developmental milestones and is a keystone example of a tertiary-play process.

Avoiding all risky play, such as tree climbing, exploring the wilderness, or wrestling, may compromise the value of active play (Little and Wyver 2008). The problem of assessing issues of making type I or type II errors (wrongly rejecting or accepting null hypotheses concerning the risks of play) is not easy to resolve in an era where children of uptight and controlling parents mingle with parents more flexible, or, perhaps, simply inattentive. Similarly, some claim that depriving children of interaction with nature may be detrimental (Louv 2008). We do not see play in naturalistic settings emphasized in the traditional play literature (Clements and Fiorentino 2004; Carlisle 2009; Singer, Golnikoff, and Hirsh-Pasek 2006). In fact, recent research suggests that children view green and natural areas more favorably as play spaces (Jannson 2008). Such spaces reduce stress (Wells and Evans 2003), they enhance the quantity and quality of physical activity (Dyment and Bell 2008), and they alleviate symptoms of Attention Deficit Hyperactivity Disorder (Kuo and Faber Taylor 2004; Faber Taylor and Kuo 2009). Even outdoor activities such as school gardens have positive cognitive and behavioral benefits (Blair 2009). All these findings support the view that play needs to be more central to our understanding and appreciation of evolutionary history and the ecological context in which it occurred.

What about recent trends to eliminate competitive athletic games in which some less coordinated students may not perform well? This may also be a mistake, if the children want to participate and are not pressured to do so. We do

not eliminate chess tournaments, spelling bees, art, music, crafts, or science fairs because some children are not good at these activities. Free play is not the same as physical education or art classes. On the other hand, to encourage children to try out novel activities, it may be important to study the means of arranging environments in order to do so for various populations. Exploratory play may be quite useful here. In the final analysis, encouraging a great diversity of play types involving various levels of social and solitary activity, role playing, pretense, construction, games, drawing, and the like may be beneficial. Nevertheless, we lack scientific certitude about which of these activities lead to what outcomes at what costs. This lack needs to be assessed.

Finally, although we may have little direct knowledge of how other species—or even various human populations—experience their play, on a behavioral level we see compelling commonalities that tap ancient systems in the brain and repeatedly emerge in certain contexts. At this stage of our knowledge, we may best carefully observe and follow, with due caution, the biological and evolved propensities humans have to play, accepting that the most important aspects of play are that it be fun, that it provide memories (conscious or not), that it give children varied experiences, and that it enhance their confidence in their ability to negotiate the world successfully and enjoyably. We can hope this will produce adults who can get beyond the "work" in their daily routines and, through play, derive adaptive experiences that make for fulfilling, even creative, lives. Comparative studies on the varied roles of play in other species will, I predict, suggest and point to enhanced means to aid our own, including the societal changes needed for success.

References

Barros, Romina M., Ellen J. Silver, and Ruth E. K. Stein. 2009. School recess and group classroom behavior. *Pediatrics* 123:431–36.

Bekoff, Marc, and Jessica Pierce. 2009. *Wild justice: The moral lives of animals.*

Blair, Dorothy. 2009. The child in the garden: An evaluative review of the benefits of school gardening. *Journal of Environmental Education* 40:15–38.

Burghardt, Gordon M. 1984. On the origins of play. In *Play in animals and humans*, ed. Peter K. Smith, 5–41.

———. 2005. *The genesis of animal play: Testing the limits.*

———. Forthcoming. Play. In *Encyclopedia of animal behavior*, ed. Michael Breed and Janice Moore.

Burghardt, Gordon M., Brian Ward, and Roger Rosscoe. 1996. Problem of reptile play: Environmental enrichment and play behavior in a captive Nile soft-shelled turtle, *Trionyx triunguis*. *Zoo Biology* 15:223–38.

Carlisle, Rodney P., ed. 2009. *Encyclopedia of play in today's society*.

Catz, Jacob. 1655. *Houwelick, dat is, Het gansche beleyt des echten-staets. Kinder-spel*.

Clements, Rhonda L., and Leah Fiorentino, eds. 2004. *The child's right to play: A global approach*.

Dapporto, Leonardo, Stefano Turillazzi, and Elisabetta Palagi. 2006. Dominance interactions in young adult paper wasp (*Polistes dominulus*) foundresses: A playlike behavior? *Journal of Comparative Psychology* 120:394–400.

Dewsbury, Donald A., ed. 2009. Charles Darwin and psychology, 1809–2009. Special issue, *American Psychologist* 64:67–150.

Diamond, Judy, and Alan B. Bond. 2003. A comparative analysis of social play in birds. *Behaviour* 140:1091–1115.

Dyment, Janet E., and A. C. Bell. 2008. Grounds for movement: Green school grounds as sites for promoting physical activity. *Health Education Research* 23:952–62.

Faber Taylor, Andrea, and Frances E. Kuo. 2009. Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders* 12:402–9.

Fagen, Robert. 1981. *Animal play behavior*.

Gitlin-Weiner, Karen, Alice Sandgrund, and Charles E. Schaefer, eds. 2000. *Play diagnosis and assessment*. 2nd ed.

Groos, Karl. 1898. *The play of animals*.

Hofferth, Sandra L., and John F. Sandberg. 2001a. Changes in American children's time, 1981–1997. In *Children at the millennium: Where have we come from, where are we going?* ed. Sandra L. Hofferth and Timothy J. Owens, 193–229.

———. 2001b. How American children spend their time. *Journal of Marriage and the Family* 63:295–308.

Jannson, Märit. 2008. Children's perspectives on public playgrounds in two Swedish communities. *Children, Youth and Environments* 18:88–109.

Johnson, James E., James F. Christie, and Thomas D. Yawkey. 1999. *Play and early childhood development*. 2nd ed.

Kuo, Frances E., and Andrea Faber Taylor. 2004. A potential natural treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a national study. *American Journal of Public Health* 94:1580–86.

Lewis, Kerrie P. 2005. Social play in the great apes. In *The nature of play: Great apes and humans*, ed. Anthony D. Pellegrini and Peter K. Smith, 27–53.

Little, Helen, and Shirley Wyver. 2008. Outdoor play: Does avoiding the risks reduce the benefits? *Australian Journal of Early Childhood* 33:33–40.

Louv, Richard. 2008. *Last child in the woods: Saving our children from nature-deficit disorder*. Rev. ed.

Martin, Paul, and T. M. Caro. 1985. On the functions of play and its role in behavioral development. In *Advances in the study of behavior*, ed. Jay S. Rosenblatt, 15:59–103.

Mitchell, Robert W., ed. 2002. *Pretending and imagination in animals and children*.
Panksepp, Jaak. 2009. Primary process affects and brain oxytocin. *Biological Psychiatry* 65: 725–27.
Panksepp, Jaak, and Jules B. Panksepp. 2000. The seven sins of evolutionary psychology. *Evolution and Cognition* 6:108–31.
Pelligrini, Anthony D. 2009. *The role of play in human development*.
Pellegrini, Anthony D., and Peter K. Smith. 1998. Physical active play: The nature and function of a neglected aspect of play. *Child Development* 69:577–98.
———, eds. 2005. *The nature of play: Great apes and humans*.
Pellis, Sergio M., and Andrew N. Iwaniuk. 2000. Adult-adult play in primates: Comparative analyses of its origin, distribution, and evolution. *Ethology* 106:1083–1104.
Pellis, Sergio, and Vivien Pellis. 2009. *The playful brain: Venturing to the limits of neuroscience*.
Power, Thomas G. 2000. *Play and exploration in children and animals*.
Singer, Dorothy G., Roberta Michnick Golnikoff, and Kathy Hirsh-Pasek, eds. 2006. *Play = learning: How play motivates and enhances children's cognitive and social-emotional growth*.
Špinka, Marek, Ruth C. Newberry, and Marc Bekoff. 2001. Mammalian play: Training for the unexpected. *Quarterly Review of Biology* 76:141–68.
Sutton-Smith, Brian. 1997. *The ambiguity of play*.
Wells, Nancy M., and Gary W. Evans. 2003. Nearby nature: A buffer of life stress among rural children. *Environment and Behavior* 35:311–30.
Winnicott, Donald W. 1971. *Playing and reality*.