To our parents
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FOREWORD

Psychologists have recently realized that happiness, laughter, joy, affection, and related phenomena have been neglected and are now developing a new specialty termed “positive psychology.” For too long they were putting most of their efforts into dealing with psychological and behavioral disorders: grief, trauma, jealousy, anger, violence, fear, pain, suffering, and loss. There is also a growing focus on psychological well-being, pleasure, and even happiness in non-human animals in laboratories, zoos, and even in nature itself. Play, broadly conceived, may be a major process underlying lives worth living.

Serge and Vivien Pellis end their marvelous volume by asserting that play is still a mystery, and one to be enjoyed. Certainly a world without mysteries, let alone pleasure, would be a dull one. But solving mysteries is not only what gives scientists their kicks, but is really what science is all about. For scientists, solving one set of challenges inevitably raises further mysteries to contemplate and investigate. Procedurally, this situation is comparable to those early video games, where finding the location of one treasure brought on the next level and setting, which one had to puzzle out, typically for an even more valuable cache, all the while confronted with more dangerous pitfalls, traps, enemies, and competitors. This book raises the prospect of valuable treasures awaiting students of play, though not necessarily of the kind anticipated by those who pioneered the study of play in animals and children in the nineteenth and early twentieth centuries.

A careful reading of this book will show that social play, in particular, is far less of a mystery than it was even a decade ago. This advance is due in large part to the breadth and depth of the studies by Serge and Vivien Pellis, often in
so the experience gained, as juveniles, from play, must have provided them with some training in social competency. The reason for this is that, even in extremely competitive forms of play fighting, subjects learn that to keep playing means to accept some pain. In addition to refining their fighting skills, the subjects learn that pleasurable social interactions sometimes involve physical pain, as well as psychological pain arising from loss of control. This lesson necessarily provides the basis for making finer discriminations about social events — and so training for social competency! Whatever the origin of play fighting, it contains ambiguity — “did you mean to hurt me or not?” It is precisely this ambiguity that leads to many of the benefits gained from play fighting. Because of this commonality across all forms of play fighting, many of the lessons learned from rats can be applied to people. We will explore these implications in our next chapter.

In the animal kingdom, there are about thirty-five phyla; that is, every species of the known million or so species of animal can be grouped into one of thirty-five distinct body plans. Armed with a catholic, but rigorous, definition of play, Burghardt has identified examples of play-like behavior in only three phyla — vertebrates, mollusks, and arthropods. Within those phyla, only some lineages have been prolific in spawning playful species. One of the most prolific lineages is the vertebrate class, Mammalia. But even within this playful lineage, not all species play and, of those that do play, some do so in a simple manner and some in a complex manner. Our own analysis of play fighting in murid rodents, that we fleshed out in chapter 3, illustrates this variation. From such wide-ranging, comparative analyses, we can conclude that play in general, and play fighting in particular, must have evolved multiple times. That is, when certain enabling conditions coalesce, playful behavior emerges. As we have argued in chapters 4 and 6, one of the functions of play fighting in the juvenile period is to facilitate the development of social competence, and this seems to be true for both rats and monkeys — mammals from different orders (Rodentia and Primates). Similarly, in rats and in many primates, during adulthood, play fighting is used to navigate through both sexual encounters and non-sexual relationships (see chapter 5). These similarities are true even though in rats, play fighting is a modified version of sexual behavior, and, in most primates, is a modified version of serious fighting.
Thus, because they serve similar functions, behaviors that began from different origins have converged. Because of those functions, the behaviors have been modified in similar ways to serve them better.

If we compare the organization of play fighting in species from different lineages where play has converged onto similar functions, we can begin to tease apart exactly which aspects of the behavior serve those functions. Note that in chapter 3 we focused on species’ differences in order to understand how lineages from a common ancestry could diverge, but now, we are turning to behavioral similarities between animals from different lineages so as to understand how the function(s) of play fighting have shaped the behavior. In playful species from many lineages, some have retained play fighting into adulthood and have co-opted it for use as a means of social assessment and manipulation. But what is it about play fighting that makes it useful for such a purpose?

Quite simply, play fighting contains an element of ambiguity – there is always the risk that a punch, slap, kick, or throw was deliberately intended to be more painful than the receiver of that action had expected. Because it is play, one’s partner has to be given the benefit of the doubt, but how many transgressions have to be tolerated before it is concluded that the partner is taking unfair advantage? We believe that this gray zone of uncertainty endows play fighting with its value as a tool for social assessment and manipulation. Depending on the nature of the relationship, taking advantage of the situation in a playful context can tell one much about the robustness of the relationship; alternatively, it can be informative about the weakness of one’s social partner, and, hence, how ready the relationship is for a change. Again, as they have done so many times in this book, rats provide a good model that we can use to understand this situation. We can therefore re-explore the uses of ambiguity in the play fighting of adult rats, and then, from that vantage point, we can expand the view to include other mammals, including humans.

The Uses of Ambiguity

Adult male rats use play fighting-like behavior to facilitate copulation during sexual encounters, as well as to assess and manipulate social partners in non-sexual, dominance-related contexts. Within the colony, subordinate males use play fighting as a means to maintain friendly relations with the dominant male and, during both within- and between-colony encounters, males can use play fighting to assess the dominance-holding capabilities of other rats. It is the play fighting in these non-sexual contexts that most closely resembles the play fighting seen in juveniles. Initially, this seems surprising, given that play fighting in this species involves elements of sexual behavior, but as we described in detail in chapter 6, precocial sexual behavior in the ancestral lineage was likely modified and co-opted into non-sexual contexts. Many other species of mammals besides rats have also been reported to engage in adult–adult play in similar contexts. However, unlike rats, some species have exaggerated the use of play fighting in courtship, and, in some lineages, play fighting has become either integral to courtship or is an option available under certain conditions. An example of each may better illustrate these two conditions.

Pottos are nocturnal, tree-living primates. Like lorises, which we discussed in chapter 5, male and female pottos maintain independent home ranges, forage independently, and generally sleep by themselves. This pattern of behavior is thought by many researchers to resemble closely the ancestral condition in the primate order. While antagonistic to territorial intrusion by members of the same sex, males will visit females that live in territories that overlap their own. A male will intrude into the territory of a female, night after night, until she becomes accustomed to his presence. At this juncture, she will allow him to groom her. Over successive nights, the grooming not only becomes prolonged, but also, reciprocal. With yet more nights and more mutual grooming, the pair begins to engage in play fighting. They hang upside down on a branch by their feet and grapple with their forelimbs, grabbing and pulling at one another (figure 7.1). After several nights of this grooming and grappling play, the pair may copulate. The sequence of ever more intimate handling of one another seems to be necessary to overcome the antagonism that individuals exhibit toward intruders into their territories. Play fighting, then, is a crucial component of potto courtship.

Moving onto a somewhat larger mammal, a male grizzly bear, during the mating season, may restrict the movements of a female to a secluded location, away from other bears. Over several days, they will make periodic contact, with some of that contact involving head-to-head wrestling and pawing—that is, play fighting. Whether such contact occurs, and for how long it proceeds, seems to be regulated by the female. The play fighting of the bears appears to be an important means by which to reduce the aggression between these otherwise solitary animals. Although this seems similar to the case of the pottos,
there is one critical difference. When male–male competition is more intense among grizzly bears, especially in high-density populations, this prolonged building of a temporary sexual bond does not take place; instead, males engage in more coercive patterns of courtship. Thus, for some species, using play fighting as an element of courtship is a conditional strategy, one that is used only under certain conditions. 7

Play fighting is also reported in non-sexual contexts for the adults of many mammals, and these fall under two general categories: to build and maintain strong social bonds and to gain advantage over a social partner by changing the nature of the relationship. Like adult rats, many species of mammals, including greater bush babies, common marmosets, slow lorises, and New World deer, use play fighting to establish and maintain social bonds and, again, like rats, many species, including chimpanzees and Old World deer, use play fighting to test existing or emergent relationships. 8 Whether these affiliating and testing functions of play fighting extend to interactions with novel animals, such as an intruder into the colony, seems to vary across species. As we have already noted, adult rats use play fighting both for affiliation with the dominant colony member and to test for opportunities to reverse dominance relationships within the colony, as well as to determine whether dominance can be established when unfamiliar adult males are encountered. It is intriguing that both the slow loris and the greater bush baby use play fighting within their colonies for social affiliation, but that only bush babies use play fighting in a rat-like manner when encountering unfamiliar animals in a neutral arena. Similarly, even within-colony use of play fighting can vary across closely related species. While sub-adult spotted hyenas appear to use play fighting for affiliation, and hence, for integration into the clan (i.e. to establish and maintain social bonds), sub-adult brown hyenas preferentially engage the adults in play fights, indicating that they are probing for a position in the clan’s dominance hierarchy. 9

And on to Humans

As occurs in rats, humans can also use a playful context to establish and test social relationships, by providing a relatively safe setting within which to explore them. If one oversteps the boundaries tolerated by one’s partner, then “sorry, I was only playing” provides a graceful exit. Not unexpectedly then, in humans, the problem of overcoming initial reticence or unfamiliarity in the early stages of courtship can be solved by playfully flirting: this can involve wrestling, gentle hitting, and tickling. In such courtship play, women seem to tolerate a narrower range of acceptable playful contact than do men, even though with respect to their own behavior, they allow themselves a broader range of intensities of contact. 10 This latter observation highlights something important about using play fighting in a socially manipulative manner. The boundaries of acceptable play behavior can vary across partners and contexts. Thus, the use of play fighting as a means for assessing and manipulating partners can be very taxing both emotionally and cognitively, as actions need to be evaluated continually. Two important questions arise from this: first, are there alternative ways that playful interactions can be used for such social testing? Second, are there experiences early in life that can lead to the improved use of playful ambiguity? We will deal with the second question later in this chapter, and for now, examine only the issue of the forms that play fighting can take.

As well as the ambiguity inherent in play fighting, another of its critical features is that it involves physical contact. We have already discussed how making gentle physical contact can be quite calming because it induces the release of endogenous opioids, but it can also be informative. A partner’s response of
to reduce stress and facilitate bonding, as well as to gain status. Thus, using the “I was only joking” gambit is not unlike the “I was only playing” ploy. The give-and-take of jokes, which are often delivered at the expense of someone else, is an effective way with which to probe for the strength of relationships and for the weaknesses that can be exploited. Again, the similarity to play fighting is remarkable. A further similarity between the two is that, just like play fighting, humor is more often used by males, both as boys and as men, even though there seem to be few differences between the sexes in their ability to appreciate humor. It is conceivable, then, that with the advent of spoken language, humans developed a verbal, non-physical form of play fighting, a form of social interaction that is intimate, informative, and ambiguous. The use of a formalized, but playful, verbal banter has been documented in many African-American communities as a means by which to reinforce valued social relationships and probe suspect ones. It seems highly plausible that, depending on the cultural milieu, the functions of speech that either enable social bonding to occur, or which confer a social advantage, have been promoted. An excellent example of the use of verbal banter, but with a sharp edge, for elevating one’s social status—social climbing—is shown in the 1996 film by Patrice Leconte, *Ridicule*, in which courtiers, so as to gain favor in the court of Louis XVI of France (1780), poke fun at other, more dominant, courtiers, but do so in a manner that allows them to gain the better of one another without it being too obviously vicious. The film most ably demonstrates that the boundary between playful joking and insult can be very narrow and that only the most skilled are capable of success.

Harking back to our layer-cake model for the evolution of play fighting that we developed in chapter 6, we can identify some of the potential building blocks that led to human humor and laughter. First, there are the facial gestures that are associated with play fighting. Second, these gestures eventually evolve the capacity to arouse, independently, the same feelings as play itself. Third, verbal banter takes over, or adds to, the modes of relationship building and testing that are based on touch. Fourth, verbal communication becomes sufficiently sophisticated so as to contain all the elements that are essential for contact-based play fighting: rewarding behavior that is informative but suitably ambiguous to be used to navigate and test social relationships. The first two steps are consistent with the evidence that we have already explored, which indicate that the neural mechanisms that make play possible and plea-
surable are both present and similar across all playful mammals— at least, for the small handful that have been studied. The next steps are purely speculative, since there are no extant species that fill the cladogram between chimpanzees and humans. Nonetheless, this speculation can be useful in helping direct researchers to identify where in the brain to look for those uniquely human attributes.

We would also be remiss if we did not point out that there are hints of humor in our closest living relatives, the chimpanzees. In one example, a juvenile chimpanzee that was living in a colony maintained on a ranch in the USA was seen to hide under a parka, squat down, and crawl towards a herd of horses in a corral. The horses did not appear to take any notice of this movement. Once at the edge of the corral, the chimpanzee jumped up, removed the parka, and flayed it about, and the horses scattered in panic. The chimpanzee ran off, while simultaneously making panting noises, similar to that of a human laugh, and with an associated play face. Once the horses had settled down, the chimpanzee then repeated its performance. We certainly know children who would think these antics great fun!

All joking aside, even with laughter and humor as uniquely human derivations of mammalian-typical play fighting, we also know that contact-based play fighting is used by adult humans. A version of play fighting that is more recognizably like that of pre-adolescent children has been well studied in post-pubescent children, especially in boys, where it is employed both to assert and gain dominance. As shown in our studies of rats, dominance can be negotiated through play fighting; this means that these animals do not have to resort to full-blown fighting to settle any problems in their relationships. Whether it is employed by rats, hyenas, monkeys, or humans, play fighting offers a level of nuance in social interactions that permits differences to be sorted out without the use of extreme violence. It would seem that adult animals that are better skilled at using the ambiguity inherent in play fighting will also be better at negotiating intricate, social worlds. But before we discuss how these skills are developed, we should reiterate that, under certain situations, humans, as well as some non-human animals, are able to use play fighting to gain social advantage. Of course, this means that there are losers as well as winners, whether the game is played “nicely” through play, or “nastily,” through more explicitly coercive means.

This darker side of playful fighting was demonstrated well by Brian Sutton-Smith, in an historical survey of play in the school grounds of New Zealand. He found that, on occasion, a playful overture offered by one child could be used as a pretext to torment another. There is little doubt that this experience will resonate with many a reader. Indeed, one of the authors of this book (Sergio) spent the first two years of his secondary schooling (7th and 8th grades) in Australia at an all boys’ school, which is not always the best environment in which to be a loner. One group of young toughs took great delight in initiating the new boys to the ways of the school playground. Under the guise of a smiling face and a playful demeanor, one of the bigger boys would throw you to the ground— usually in a grassed area— and then pin you on your back so that you could not move. He would then proceed with the “rats” treatment, which involved repeatedly tapping you, with his forefinger, and with an uncomfortable degree of force, on your chest, while, at the same time, shouting in your face, “rats, rats, rats ...” in quick succession. Any complaints or threats of retaliation by the victim simply led to one being given a more prolonged treatment of “rats.” There was no way out of this fix but to smile and laugh while simultaneously enduring it— that is, to pretend that you accepted this treatment as an act of play. The longer-term solution to such “playful” bullying involved two complementary strategies. First, you picked fights with the smaller members of this marauding gang of young toughs, especially at the times in which they were isolated from their gang. This established your reputation as to the limits to which you could be pushed. Second, you formed a gang of your own, with a sufficient membership of boys who were tall and bulky— and hence, intimidating— for their age. This latter strategy inhibited the other gang from picking on any one member of your gang, especially if you always made sure that you traveled in the school playground with three or four of your own gang members.

Another important issue discussed by Sutton-Smith is well illustrated by this tale of “rats.” That overt facial expressions and other behavioral signs of playfulness are not necessarily foolproof ways of distinguishing playful from non-playful fighting. We can assure readers that Sergio did not enjoy being repeatedly tapped on the chest, no matter how much he smiled. Fortunately, in the case of children or young adults, observers can ask the participants whether they had been engaged in a serious or playful fight. Even though people are not always truthful about their behavior, asking the participants may provide additional information that would enable researchers to make a
more sound judgment. But when it comes to non-human animals, we are denied this additional information and so are forced to use only the overt, observable behavior. So, how do we know for sure that any particular play fight is truly regarded as such by both participants? We do not. To make such a judgment, we need detailed knowledge about the particular species' behavior and knowledge about the individuals involved and their relationship.

Based on intimate knowledge such as this, Clara Jones was able to report that, among adult howler monkeys, higher status individuals used play fighting as a means by which to keep monkeys of a lower status in their place. Thus, a non-damaging form of behavior is used to remind other members of the social group who is the boss, and is done without having to resort to a serious fight that could force a subordinate to retaliate. The situation is much like that which we discussed earlier concerning jokes: the more dominant member of an office can make the occasional joke at a subordinate's expense, and in so doing, is reminding everyone, albeit in a playful manner, exactly who is in charge.

That there is a dark side to play should not come as a surprise — after all, play fighting is being used in these instances as a means of social assessment and manipulation. Therefore, we should expect that play fighting will span the spectrum from positively reinforcing valued relationships to coercively manipulating social rivals. Play fighting thus offers its users a wide range of options in trying to adjust social relationships to their advantage. The choices that we have are not between everybody loving one another and living together in egalitarian bliss versus living in dictatorial brutality, but rather, between convincing someone to give you a share of the pie or taking it from them whether they want to give it to you or not. In democratic, law-bound societies, overt brutality in gaining what we believe to be our just desserts is unacceptable and is likely to elicit fierce resistance. Instead, finding ways of getting others to cooperate with you is the socially and legally acceptable route to follow. In this context, the wider the range of alternative strategies available to an individual, the better that individual will be able to navigate the complex social networks of large, democratic societies with their global markets. If the story that has unfolded for rats is any guide, our suspicion is that experiencing play fighting as juveniles is crucial for the development of the nuanced social skills so necessary for success in the modern world.

How to Become Good at being Ambiguous

When asked to discriminate between instances of playful fighting and serious fighting, children are more accurate than adults in determining this, and, in adults, men are more accurate than women. However, if women have had personal experience with play fighting as children, they are better able to discriminate than those who lack such experience. Clearly, experience can make a difference. To our knowledge, there are no studies available that have examined whether differential experience of play fighting in humans leads to more subtle discriminations of playful encounters in adulthood. However, there are some studies that indicate that children who have had more experience with play fighting are also better able to solve social problems. Further, the experimental data on rats that we have extensively reviewed in the previous chapters suggest a direct, causal connection between play fighting and social competence. Given that we have also reviewed experimental data on non-human primates that paint a picture similar to that for rats, it is not unreasonable to suspect that the same should apply to humans. However, there is a persistent problem with how best to interpret childhood play fighting that we believe unnecessarily confounds the issue of whether experience with play fighting promotes social competence.

There seems to be widespread consensus that play fighting in post-pubescent children is organized and used so as to compete for dominance, and, at least, in male-male dyads, play fighting in adolescence does appear to have a rougher quality, making it more like a form of quasi-aggression. However, when it comes to pre-pubescent play fighting, there is less agreement as to whether it functions as a means of combat training or improves social competence. Reconsideration of how play fighting unfolds will help resolve this conflict. As we discussed in chapters 3 and 6, play fighting must contain a threshold level of both competition and cooperation, and irrespective of whether play fighting is more competitive or more cooperative, every species that engages in play fighting must solve the reciprocity problem in order for it to remain playful. That is, players need to exercise fairness in their play fighting. In species in which reciprocation comes late in the play sequence, the tactics of attack and defense are performed in a manner comparable to how they are performed in serious fighting; in such species, play fighting can serve as practice for adult aggression. In contrast, in species in which reciprocation
comes early in the play sequence, the tactics of attack and defense only superficially resemble those used in serious fighting. In such species, play fighting is a poor means of practicing serious fighting. Examples of the former include degus and pigs, and the latter, rats and many primates (see figure 6.3). Although there are some good, descriptive analyses of play fighting in human children, they are of insufficient depth to determine clearly whether their play fighting is more like that of the degu or the rat. 26

That personal experience with play fighting can influence one's ability to discriminate between the playful and aggressive behavior of others suggests that, even if a child's experience of play fighting does enhance later fighting ability, it must also change their ability to differentiate between social actions and weigh them appropriately. Thus, even an extremely competitive form of play fighting appears to have an in-built mechanism for such social training—subjects learn that to keep things playful not only requires that they accept some pain, but also accept that their partner must have the opportunity to win. 27 That is, in addition to refining their fighting skills, subjects learn that pleasurable social interactions sometimes involve physical pain, as well as the psychological pain that arises from loss of control. Therefore, no matter whether play fighting in the juvenile period is primarily designed to promote the development of social skills or combat skills, the subject's ability to make more nuanced discriminations about the social action of others should be enhanced. Therefore, whatever else play fighting is good for, it is clear that it promotes the development of social skills. This, in turn, has implications for how we, as a society, deal with play fighting in childhood.

Current textbooks on children's play devote very little space to the discussion of play fighting—often only in the context of whether it is really play. Even a recent book aimed expressly at promoting play in childhood does not contain the terms "play fighting" or "rough-and-tumble play" in its index. 28 There are several reasons why this neglect is unfortunate. First, play fighting has been shown to represent between 5–10% of the spontaneous play occurring in the school playground. Second, despite variations in the imagery component of play fighting across cultures and historical times, play fighting is remarkably similar across the world. Third, it is the one form of human play that most closely resembles the play of non-human animals. 29 That it occurs spontaneously, is consistent across cultures, and is comparable to the play of other species, means that this is a form of play in humans that is likely the most tractable as an object of study, and the one most likely to offer insights into forms of play that are unique to humans, and are, contextually and culturally, more variable. Not the least important point is that the experiences gained through play fighting as a juvenile are very likely to have consequences for the skills that, later in life, are related to social competence.

Toward the end of the 1990s, when our work on play fighting and that of many others around the world was leading to the inexorable conclusion that, in rats, juvenile experience with this behavior was crucial for the development of social competence, we had an epiphany. It occurred on a visit to Paris, France. After having spent at least half of our adult lives in North American cities, we were accustomed to seeing children spending their leisure time mainly in shopping malls, and, when outside, under the supervision of parents or teachers, or engaged in organized games, such as football. In Paris, as in many European cities, most people live in the central part of the city in small apartments, as compared to the houses of North America. It is said that Paris is but a collection of villages, and in the modern city, many of these "villages" come with their own verdant little square. One day, we were out walking at around 4 o'clock in the afternoon, when we passed one such place, the Place des Vosges, and noticed that parents and guardians were bringing their children, of primary school age, into the park. We entered and sat down on a bench, and saw, very quickly, what was happening there—the adults sat around the periphery, chatting with one another, and the children congregated in groups on the grassed area. Some children were playing ball games, others had model cars or planes, and some had skipping ropes. Still others ran wild, chasing each other, tackling one another and, yes, play fighting. Occasionally, a child would appear to land hard on the ground, and then would stand, and begin to cry, while at the same time, turning to look in the direction of whom we assumed to be a parent or guardian. The child would quickly recover and again join the fray. We had almost forgotten what it was like to see children playing like children and engaging spontaneously in myriad forms of playful endeavor. Their caretakers were there, providing security if a child were hurt or was unfairly treated by another child, but, otherwise, it seemed that the choice of games and play partners was decided solely by the children themselves.

Our observation of children being allowed to engage in spontaneous play fighting with varying degrees of intensity is at odds with the ever growing number of newspaper stories with which we had become familiar in North
America, where more and more schools and public parks are banning any form of roughhousing by children, whether play fighting or chasing. Fear of injury and the threat of litigation are no doubt reasonable concerns of those responsible for the well-being of children and so there has been an escalation in the banning of any form of unstructured play. Many school districts have already eliminated recess, even though the little empirical evidence that does exist indicates that giving children periodic opportunities for unstructured activity throughout the school day enhances their scholastic performance, rather than detracts from it. Given the ever-growing rates of obesity among children, such restrictions are likely to be deleterious in many ways, but our main concern here is with the potentially negative impact that they would have—or are having—on the development of social competence. Of course, this is not to belittle legitimate concerns about injury, bullying, and litigation. Nonetheless, the French example described above offers a compromise—adults are present offering a safety net if one is needed, the play is concentrated on thick mats of grass, so minimizing the likelihood of serious injury, and there are sufficient children available for individuals to select, for themselves, activities and partners that are best suited to their predilections. These features for making play opportunities safer are the very ones that are starting to be recommended by educators who are concerned about the ever-diminishing opportunities for children to engage in play fighting.

Other options could include the development of games, such as computer-based ones, that engage the skills that are essential for children to learn in play fighting, such as turn-taking, and thus fairness. These games could possibly train children in these crucial skills, but, at the same time, would avoid their risk of injury. While this option has its merits, it does not provide the vigorous exercise effects that are associated with play fighting, nor does it include physical contact, which, as we saw earlier, may enable critical, social bonding experiences and information gathering to be had. These examples illustrate that there are ways of minimizing the risks while not eliminating the important experiences that arise from play fighting. It is imperative that we understand how the experience of play fighting improves a person’s later abilities both to navigate through ambiguous social interactions and to use ambiguous patterns of interaction to good effect. Even though we do not know as yet the exact neural mechanisms that are involved in play fighting, we do know from observational studies on children and experimental studies on non-human animals, that it would be wise if we, as a society, found ways to allow our children the opportunity to engage in this behavior. Before leaving our discussion of the role of play fighting experience in the juvenile period of development, we will just touch on one more way in which our knowledge of rats may be helpful in resolving otherwise perplexing issues.

Why is Play Fighting More Frequent in Boys than Girls?

A major problem with the hypothesis of play fighting as a “tool for refining social competence” is that women are more socially competent than men, yet they engage in less play fighting as children. However, this theory may not only be salvaged, but may even be reinforced by this sex difference. Several facts need to be considered. First, play is a context-sensitive behavior. It is most likely to occur in resource-rich environments and is less likely to occur in resource-poor environments. So, play has to be a contingently adaptive strategy—that is, it cannot be critical for development, but rather, when it is available, it is helpful. Second, males are generally more aggressive, and often, the most dominant males are the ones who are most aggressive, and so the least sensitive to social nuance. Third, females are, generally, less physically imposing than males and so rely on more subtle social skills than males to meet their needs. Based on these sex differences, it would seem reasonable to predict that in females, those brain circuits that are needed for social competence are already developed, independently of social experience, to a greater degree than in males. Recall that in chapter 4 we showed that play fighting experience in rats in the juvenile period led to alterations in the prefrontal cortex of the brain, with neurons of the OFC becoming more complex and those of the mPFC less complex (figure 4.7). Also recall that we cited evidence from neuroimaging studies on humans that showed that whereas the OFC is involved with cooperation, the mPFC is involved with competition (see chapter 4, endnote 82). In female rats, the OFC is more complex and the mPFC less complex than it is in males, whereas in male rats, the opposite is true, with the mPFC neurons being more complex and OFC neurons less complex. These sex differences are dependent on exposure to gonadal hormones during early development. The core, sex-typical biases are thus built into each sex in ways that are not likely to be contingent on social experience.
Of course, we have already examined evidence that play fighting experience in the juvenile period can alter social competence and so, presumably, the brain mechanisms that mediate this, but what these findings also suggest is that processes are in place to ensure that females have a brain that is more capable of coping with the social world, and males have one that is more capable of competing with rivals. One reason for such a bias is that it is likely, generally, that a female’s reproductive success is dependent on her social competence, be it in her interactions with other females, with males, or, most certainly, with her offspring. In contrast, for males, reproductive success is more variable, with social skill being only one of a possible number of assets that are critical. There is evidence from studies of an increasing number of species that indicate males may adopt any one of a multitude of strategies so as to gain sexual access to females. For example, while large, aggressive, and dominant males may have priority of access to females, subordinate males may use more subtle techniques to gain some reproductive opportunities. This is well illustrated by the male “seduction” of females in orangutans.

The largest, most dominant, male orangutans in an area will climb to a high point on a tree in their territory and emit what are termed “long calls.” The sound of these calls travels vast distances in the forest, notifying receptive females of their presence. Female orangutans find these calls appealing and will travel to the caller’s location for an assignation. Because males that are small in stature cannot fake long calls, they have to resort to using different strategies to gain access to females. The smallest adult males in the area may follow a female, and, for prolonged periods of time, interact with her playfully. This may lead to her allowing copulation to take place. Moderately sized males may resort to intercepting females as they travel to the attractive dominant caller and use their superior body size and strength to force copulation. Depending on the male’s size and status, he may demonstrate little social finesse, brutal social behavior, or friendly persuasion. Except for certain extreme situations, it is not possible to predict the kind of social context in which a male may find himself. In one social context, an aggressive approach may work, but in another, a more subtle, socially sophisticated one may be needed. Aside from size and age differences, animals also vary in their temperament, which, in turn, affects which of these strategies they adopt.

The most thoroughly studied temperamental feature is that of the “boldness-timidity” gradient, a dimension along which individuals from a wide range of species have been shown to vary. Furthermore, such temperament differences have been shown to be consistent across situations, so that if an individual is bold in one context it will also be bold in another. Finally, some of the underlying genetics and neural mechanisms for such variation in temperament have been characterized. For example, among male rats, bolder, more aggressive males are more likely to become dominant than timid ones and are also more likely to exhibit threat postures. Timid rats, on the other hand, are more likely to avoid other males and freeze in their presence. Further, as juveniles, bolder rats are more likely to initiate play. Of course, if a highly timid male rat is housed with a very bold male rat, it is no surprise that the former will quickly adopt the role of subordinate and the latter the role of dominant, but what if a bold rat is housed with a bolder one, or a timid rat with a more timid partner? In the real world, where most of those encountered are likely to be only a little different from oneself, any individual may have to be able to accommodate its social behavior to the context, and this is what we have seen countless times when male rats are placed in a situation where they have to form a relationship with other male rats.

Therefore, some degree of social competency is a requirement for most animals. However, it should be borne in mind that it is the weaker or subordinate animal that has to be more attentive to the actions of the stronger or more dominant one. If sufficiently powerful, the latter can be oblivious to those that surround him or her. In the last few years, because of the repeated television footage, the blunt power exuded by the former Iraqi dictator, Saddam Hussein, is an image that readily comes to mind. He was often shown walking through a crowd, nonchalant, while all those in the crowd are fawning over him. The trouble is that it cannot be predicted, early in life, whether an individual will become a Saddam Hussein or one of his weaker vassals. It is likely that in his climb to the top, Saddam did a lot of fawning of his own.

In conclusion, a male’s need for social subtlety may vary depending on his status. Under poor resource conditions, the premium for success is to grow as quickly as possible, and doing so may require being as mean as possible so as to out-compete rival males. Under these conditions, it is attitude and strength (or size) that counts, and so prefrontal mechanisms that are critical for regulating competitive ability are more useful than a prefrontal cortex that has the capacity for a lot of cooperation, and thus, social nuance. Besides, in such a
situation, play is a luxury that can be ill afforded, and so it may not be available to alter the balance of mechanisms in the prefrontal cortex. In contrast, in a resource-rich environment, most males will likely end up having a high-quality phenotype — where all the males are big and show a similar level of competitive ability. In this situation, improving one’s non-aggressive competitive skills becomes more important, and to be good at social manipulation in the absence of using overt aggression requires bolstering the capabilities of those parts of the prefrontal cortex that regulate a cooperative form of social competence. During the juvenile period, plentiful resources trigger an increase in play, which, in turn, redirects development to increase investment in the social brain, which then leads to improved competitiveness via non-physical means. Essentially, the model we propose suggests that females are biased to develop a socially competent brain, whereas males are biased to develop a brain that is minimally socially competent but if the conditions are right, can use play in the juvenile period to develop the social brain further. This model explains three facts: (1) that males play more than females; (2) that females are more socially competent than males; and (3) that the degree of play in which juveniles engage depends on local conditions.

There is variation in the degree to which play fighting by children is tolerated in different cultures around the world. In some, play fighting by children is not merely tolerated but even encouraged; in others, it is positively discouraged. Societies also vary in the rigidity of male hierarchies and therefore in the kinds of skills that enable individuals to gain status. We hazard a guess that, in societies in which males succeed in furthering their status only via physical prowess or non-social activities, social play will be dampened or, if allowed, will emphasize competition. In contrast, in more egalitarian societies, in which convincing others to cooperate or where being able to detect subtle social maneuvers by competitors is important for social success, then not only should play fighting be tolerated, but its cooperative component should also be emphasized.

Although there may be important sex differences in the requirements for social competency, it is very likely that both sexes require at least a minimum amount of play fighting experience in the juvenile period so as to fine-tune or calibrate their assessments and reactions to others’ social actions. Richard Tremblay and his group have shown that, contrary to what had been thought for a long time, people are at their most intensely aggressive as young children, peaking at around two years of age. Then, in the course of the next two or three years, that propensity for aggression is brought under control. Indeed, children that fail to restrain their aggressiveness by this age tend to continue to be overly aggressive for life. Reciprocal playful exchanges with one’s mother, followed by boisterous play fighting experiences with one’s father, seem essential to curtail early aggressiveness. Failure to engage in such play appears to lead to an inability by the child to regulate reciprocal exchanges with peers properly, making it more likely that such children are ostracized from playing with others, which then leads to more frustration and more aggression. Thus, by these means, play fighting that begins with one’s parents and continues with one’s peers, provides a means by which a child can learn to regulate their aggressiveness. You may recall, for example, that when your pet kitten or puppy first began to play with you, it had little restraint in using its claws or even biting. It was only by chastising it and, perhaps, by smacking it lightly on the head or issuing a downright refusal to play that it learned to hold back the use of its claws and teeth. Again, we are drawn to the conclusion that play fighting has an element of “make believe,” and that the participants must accept that what transpires during such play is not to be viewed as aggression, but that, because of its inherent ambiguity, some transgression is acceptable. The problem arises when a young animal, be it a human child, a monkey, or a rat, consistently fails to restrain its actions, and so finds that it is abandoned by its play mates. As there may well be no substitute for play fighting as a means by which to learn these critical lessons of fairness, for both sexes, a certain minimum amount of play fighting may be necessary.

To sum up, what we have shown is that there are general properties of play fighting, such as its inherent ambiguity, that have been co-opted by many species to evolve a form of social interaction that can be used to probe social relationships. The advantage of such playful probing is that it can avoid escalation into vicious conflict because a fail-safe exists – the “sorry, I was only playing.” We also saw that to become skilled at such playful probing requires practice, especially as juveniles. The unpredictability that exists in play, particularly when coupled with its inherent ambiguity, makes it a fertile ground for training individuals to cope with the unexpected. Of direct relevance to the theme of this chapter is Tony Pellegrini’s observation that children that experience the most varied social play are also the most adept at developing novel solutions to social problems.
The Playful Brain

With regard to the use of playful ambiguity in adulthood, an unresolved question remains: do all species that use it have comparable neural mechanisms? We suspect that, for mammals, at least, this is the case. That is, cortical mechanisms that are able to modulate the content of play-fighting in rats are also likely to be the same as those that do so in humans. Comparative studies with rats, monkeys, and humans should resolve this matter. With regard to how the skillful use of playful ambiguity develops, the major unresolved question concerns what it is exactly that needs to be practiced. As we discussed at length in chapter 4, there are many routes, some direct and some indirect, by which experiences early in development can affect skills later in life. It is this issue of what is practiced by play in the juvenile period, and how it is done, that will be the focus of the final chapter. After all, it is appropriate that we end this book by providing a vision of where the study of play may lead. As history buffs, we also know that the past is often a good guide to the future—thus, by understanding what the arguments of the past were, we are often able to sharpen our appreciation of the data we have in the present and so formulate the questions that need to be tackled in the future.

We will end this book by tackling what we believe to be the most challenging task that lies ahead for the study of play. As this is the final chapter, we also want to make sure that the reader understands the particular approach we have taken in our own journey in studying such a complex phenomenon. As illustrated by the very structure of this book, we believe that when confronting such a phenomenon, it is necessary to engage in a two-step process: the phenomenon needs first to be fractionated into its components, and then reassembled. Taking short cuts may make the task more palatable, but may also lead one to dead ends. If the reader has managed to work their way through the detail-intensive chapters 2 and 3, they would then be well placed to understand our logic in the subsequent chapters and, hopefully, in a position to identify any flaws in our arguments. So, before our final exploration of play, let us make explicit some of the analytical tools that we think any student of complex behavior would be well advised to consider.

The Deconstruction of Complexity

As we have seen, several analytic steps are necessary to try to explain how a rat-like species with complex patterns of play-fighting could have evolved from a mouse-like species with little or rudimentary play. First, we identified a practical model species. Second, we carefully described the play-fighting of that species with complex patterns. Third, we developed a practical analytical model that would allow us to understand the complexity of the phenomenon. And, finally, we placed the phenomenon into a two-step process: the phenomenon needs first to be fractionated into its components, and then reassembled. Taking short cuts may make the task more palatable, but may also lead one to dead ends. If the reader has managed to work their way through the detail-intensive chapters 2 and 3, they would then be well placed to understand our logic in the subsequent chapters and, hopefully, in a position to identify any flaws in our arguments. So, before our final exploration of play, let us make explicit some of the analytical tools that we think any student of complex behavior would be well advised to consider.
model animal. Third, using cross-strain comparisons, between-sex comparisons, across-age comparisons, and individual variation, we characterized the organization of play fighting. Fourth, we then placed into comparative perspective the components of play fighting and its organization in the model species by examining how they differed within a cluster of closely related species. Fifth, we identified the species-level changes necessary to transform a non-playful animal into one with a complex pattern of play and mapped these onto changes at the level of brain mechanisms. Sixth, we characterized the effects of playful experience in the juvenile period on subsequent adult behavior, including motor performance, cognitive capacities, emotional stability, and social competence. Seventh, we identified some of the brain mechanisms that are altered by play experience and that impinge on various competencies. From all these steps (and all are, to varying degrees, works in progress), we began to develop a model to explain the many facets of play fighting. Notice that are altered by play experience and that impinge on various competencies.

There are several ways to conduct "analyses by synthesis". We began with a purely behavioral analysis, in which the components and their rules of interaction were characterized. If any piece of the behavioral performance remains unexplained by the synthesis, then we know that something is missing in the analysis. Only once we are confident that we understand the construction of the behavior is it profitable to shift the level of the analysis so that the underlying endocrinological, physiological, and neural mechanisms can be characterized. Failure to characterize the behavior correctly can lead to poor models of the underlying neurology. The importance of the initial behavioral analysis in guiding neurological explanation is illustrated well in our experience of studying the righting reflex.

When a cat falls, upside down, it will right itself in mid-air. To do this, the cat seems to rotate its head and neck in one direction, and then rotates its shoulders and then its pelvis in the same direction, until its whole body has rotated 180°. The completion of this sequence results in the cat landing right side up. The initial explanation for the underlying mechanism was something like this: visual and/or vestibular signals tell the cat that it is falling upside-down and these trigger the rotation of the head and neck toward the ground; in turn, the rotation of the neck stimulates receptors in the neck vertebrae that trigger the rotation of the shoulders; and this rotation involving the movement of the vertebrae of the mid-section stimulates the rotation of the lower body. Stimulation of one action creates the stimuli necessary for the next movement and so on, a classic chain reflex that produces a 180° rotation, starting at the head and neck, and ending at the tail. However, there are two problems with this explanation. First, if the cat's head and neck stabilize in space so that once prone, they remain there, the neck has to rotate in the opposite direction, to prevent the head and neck from being displaced away from facing the ground by the rotation of the shoulders. The same is true for the shoulders during rotation in the lower body. As the second neck rotation in the opposite direction does not doom the animal to make endless oscillatory rotations back and forth, it suggests that — at the very least — a modification of the traditional theory is required, to the effect that the neck reflex-stimulated shoulder rotation must be inhibited once the initial rotation has taken place. Second, when the head and neck rotate in one direction, there is a simultaneous rotation of the lower body in the opposite direction. That is, the tail end rotates before the stimuli created by vertebral movements can reach it! So, either the chain-reflex explanation needs to be modified, with both facilitative and inhibitory phases to explain the neck rotations, or a different explanation is needed to account for the concurrent rotation of the neck and tail — one that envisages the process not as a reflex, but as a motor program that is triggered in its entirety by the sensation of falling. In other words, an inadequate behavioral description can lead to an inaccurate physiological explanation. By the way, the counter-rotation by the tail end of the animal seems to stabilize the hindquarters, which thus anchors the rotation by the forequarters.

In the past couple of decades, computerized models and moving robots have been used to great effect in testing whether a behavioral analysis has yielded components and rules of behavior that actually recreate the observed, behavioral output. One of the best examples involves the huddling behavior of young rat pups. In their first week or so of life, rat pups are pink and hairless and are not, as yet, able to self-regulate their body temperature. Thus,
when their mother leaves them, their body temperature drops. To compensate for this cooling, the pups huddle together, much like people do who are stranded in the cold (figure 8.1). After many years of studying this behavior, Jeff Alberts concluded that this seemingly complex huddling behavior emerges from the interaction of simple rules: that the pups attempt to maintain contact with a vertical surface (i.e. thigmotaxis), and that they are more attracted to warm surfaces than to cool ones. These rules seemed to be sufficient to account for the huddling of rat pups of up to seven days of age, but for slightly older pups, another rule seemed to be required. Up until the seventh day, a rat pup is insensitive to the activity of adjacent pups. However, after this age, it is influenced by their activity, and becomes active or inactive based on the activity of its littermates. This became the third rule for pups older than seven days. Behaviorally, these rules seemed sufficient to explain the complex patterns of huddling; or were they? Joined by Jeff Schank, Jeff Alberts took this question to its logical conclusion by using a superb analysis by synthesis.

They began their analysis of huddling behavior by making a computerized model to represent the pups as 'stick images', and programmed them to move according to the three rules. Sure enough, when this model was programmed with only the first two rules, the cluster of sticks mimicked the behavior of pups that were seven days old or younger. But when all three rules were employed in the model, the sticks mimicked the behavior of the older pups. Next, Jeff Schank constructed small, metal robots that moved on wheels. When these “robopups” were programmed with the first two rules to guide their behavior, they resembled the younger pups, and when all three rules were employed, they behaved like the older pups. Thus, using computerized simulations and robotics, they were able to demonstrate that the rules derived from the analysis of live pups were sufficient to recreate their behavior.

This testing showed that the rules initially abstracted from the actual behavior were not arbitrary descriptions of some facets of the phenomenon, but rather were realistic renditions of the underlying rules that generate complex behavior. Although we are far from this type of sophisticated testing in our analyses of play fighting in rodents, by using a description of the proposed rules (e.g. body targets attacked and defended, preferred tactics of attack and defense in particular contexts) and testing them for their ability to account for species differences, age differences, and so on, we have some measure of confidence that the evolutionary scenario that we developed in chapter 6 is not simply a descriptive epiphenomenon.

Where do We Go from Here?

Our own history of studying play reveals how elusive a completely satisfying explanation is for this puzzling, yet intriguing, behavior. In the mid-1970s, it seemed obvious to us that a plausible explanation for juvenile play fighting hinged on it being used as a means of refining combat skills. Indeed, we began studying rats because we could exercise more control over their developmental experiences and so test, more effectively, whether play fighting did, in fact, improve their combat skills as adults. However, our confidence in the explanatory power of this practice hypothesis quickly waned as it became clear that play fighting in rats was about sex, not aggression. Furthermore, the manner in which the tactics of attack and defense are used in play fighting in rats is a poor vehicle with which to rehearse the motor actions useful for sex, much less aggression. For similar reasons, explanations for play such as it being essential for the refinement of cognitive or social skills were equally disappointing. Eventually, as our studies of play in rats, and those from many
different laboratories around the world, began to demonstrate, deficiencies in the motor, cognitive, or social capacities of play-deprived rats arose from a more general deficit in their emotional reaction to events. A fearful and anxious animal is not one that is fully capable of bringing to bear, in any given situation, all its motor and cognitive skills. Thus, when play fighting, animals are not refining motor, cognitive, or social skills, but rather are learning how to calibrate and match their emotional reactions to an unpredictable world. Now, wait a moment, hasn’t this explanation come full circle? It seems to be agreed by all that play experience in the juvenile period is about calibrating something, the question is what exactly is being calibrated—motor, cognitive, social, or emotional skills?

We hope that, having read chapter 4, you are convinced that, to a large extent, improvements in motor, cognitive, and social skills arise indirectly through play acting on the improvement of emotional skills, or more accurately, in refining the calibration of one’s emotional responses to unexpected events in the world. Of course, we do acknowledge, and provide evidence for, the possibility that some motor, cognitive, and social skills are improved, directly, by the experience of play. Nonetheless, we consider that the primary avenue for the improvement of all skills is via emotional calibration. What does seem to be beyond argument is that for a number of species—rats, rhesus monkeys, and humans included—an impoverished experience of play-fighting in the juvenile period leads to adults that have deficiencies in a variety of skills. What remains is to delineate the exact nature of the playful experiences that are necessary to produce improvements in all these skills and to pinpoint, precisely, the direct and indirect mechanisms by which they do so. However, if play is all about calibration, haven’t we all simply been arguing about what exactly is being calibrated? Not quite: by now, you should be wary of a one-theory-fits-all kind of conclusion.

Imagine an orangutan moving through the trees. It uses its heavy body to bend thick branches or thin tree trunks in the direction in which it wishes to travel, and then, when it is close enough to it, reaches out with one of its long arms and grasps the next tree or branch in its path. An adult orangutan moving through the forest in this way seems to do so without expending any effort and is fluid in its motion. Climb a tree and try moving from branch to branch in this manner—it is not easy. Similarly, when young orangutans begin to move among the trees on their own, rather than being carried by their mothers, their movements are inefficient. Clearly, they need to practice these movements, and indeed, juvenile orangutans spend a large part of their day in non-utilitarian climbing or locomotor play. Such play could be improving their climbing skills directly, or doing so indirectly, by giving the young orangutans confidence in their ability to climb without falling. That is, all this play could be contributing to dampening emotional responses to frightening situations rather than to improving motor skills. After all, it is reasonable for orangutans that are inexperienced climbers to be frightened because, as a species, they spend more time in trees than do either chimpanzees or gorillas and have up to three times more fractures of their long bones, suggesting more falls than these other apes. Of course, the two are not mutually exclusive; improved motor coordination can improve one’s confidence, which, in turn, can motivate one to try something a little more difficult and perhaps, more frightening.

So, among orangutans, play helps to improve the motor skills they need for locomotion, and does so, in part, by allowing the animals the opportunity to calibrate their movements so as to make their way through the trees effectively. As pointed out by Michael Simpson, a monkey jumping from one branch to another uses many muscles and joints, such as those of its feet to propel itself and those of its hands to grasp oncoming branches. Failure to achieve this goal could be due to an uncontrolled action by any number of muscles or joints. Play provides the opportunity for the animal to gain mastery over its anatomy. Jumping and leaping during play allows the animal to keep all things constant except for one set of muscles, so that by varying that one parameter, the animal can experience altering the force, say, that propels it from one branch to another. As play progresses, the animal should have more and more experience with varying most of the elements in its anatomical system and so have better control in making alterations to the series of actions involved. Some of our personal observations are consistent with this calibration perspective.

When we filmed play fighting in juvenile patas monkeys, we recorded instances of playful leaps. One such episode is particularly pertinent to this discussion on calibration. The three juveniles of the troop ran up a tree, one after another, to a horizontal branch, and then leapt, one at a time, towards a large, grassy patch in the enclosure. After landing, they ran back to the tree to repeat the performance. This sequence was repeated at least ten times by each
In each jump, the monkeys altered the force and the height of their leaps, so that each successive one was slightly different. From a calibration perspective, this makes sense, as small, controlled variations are made with each subsequent leap. However, our description is incomplete. As they prepared to land, the monkeys did the exact opposite of what any sane animal would do. When hurtling towards the ground, an animal will stretch its limbs downwards, and, for animals with a flexible spine, curve its back dorsally. This “parachute reaction” prepares an animal for landing on the ground and does so in such a manner as to reduce the likelihood of risk to vital organs. However, our monkeys did not do this. Instead, once they had reached their maximum height above ground, they raised their limbs laterally, thus adopting a spread-eagled posture, which caused them to land, full force, on their bellies. Landings were accompanied by sickening thuds and each monkey, before returning to the tree for a repeat performance, took a few moments to regain its composure. Although the variation in the force and height of the leaps was consistent with the hypothesis that such playful leaps are used to calibrate the motor system, the landings are not. If anything, these hard landings on their bellies would have taught the monkeys that having fun sometimes involves pain, or that pain can sometimes be fun. Thus, these landings are more consistent with the idea that play serves the function of calibrating emotional responses.

But calibration, be it of the motor or the emotional system, may be insufficient to explain all the actions performed during play. For example, while studying play fighting in a captive troop of Tonkean macaques, a type of Old World monkey that hales from Sulawesi, Indonesia, Christine Reinhart, a doctoral student from our laboratory, filmed some peculiar leaps in a pair of juveniles. The two juveniles met along a path that was enclosed, like a bower, by overhanging tree branches. They both noticed one particular overhanging branch that was lower than the others and took turns leaping upward to grab at it. As the animals squatted, aimed, and then leapt upward, they reached out with one hand (figure 8.2, left), clearly targeting the branch. Several such leaps ensued. As in Simpson’s model, and as illustrated in the jump portion of the patas monkey leaps, each successive leap that was carried out by the Tonkean macaques was only a small variation on the one preceding and resulted in small differences in the force and height of the jump. But then something changed. As their jumping progressed, each of the monkey’s jumps became more and more disconnected from what had seemed to be the original goal of their jumps – to reach for the branch. The monkeys added peculiar elements to each jump, such as spreading their hind legs and arching their backs (figure 8.2, right), which had nothing to do with successfully reaching the branch or in calibrating the movements composing a functional action.

It could be argued that these secondary, non-functional variations in the movements performed by these Tonkean macaques were designed for emotional calibration (chapter 4), or training for the unexpected. However, for these latter explanations to be true, the expected variability in the actions occurring in the play should be designed to make achieving tasks more difficult, which would train the animals not to be flummoxed by unexpected impediments to their attempts to gain their desired goal. This is illustrated well in our juvenile rats, which stand on top of their supine partners with all four of their paws, thus reducing their control over their own movements and those of their partner, by making it harder to prevent their partners from successfully counterattacking and so causing a role reversal. The peculiar movements that the Tonkean macaques incorporated into their jumps made the attainment of their goal impossible, not just more difficult, and seemed to
have been executed simply because they could be – perhaps for the sheer joy of being able to do them. Indeed, most definitions of play include some component that either explicitly or implicitly recognizes the intrinsically rewarding nature of play. 14

That engagement in the performance of some behavioral actions can be self-rewarding has been recognized in the research traditions of psychology and animal behavior, and finding the underlying currency in the nervous system that drives such pleasure has been an important part of the tradition of behavioral neuroscience. 15 Perhaps, the mechanisms that make engaging in “behavior for its own sake” are being tapped during play? If this is so, then the challenge for the future will be to unravel what aspects of the playful performance can be explained by the functional benefits that such performance may bring from those aspects that are unleashed at the time of the performance itself by the neural and behavioral mechanisms engaged. After all, while the act of eating may be explained by the essential functional benefits that eating may have for survival and reproduction, not every individual act of eating can be so explained – our ever widening waistlines are a testimony to that fact. Our view is that more comprehensive theories of play will need to integrate the functions and the mechanisms that shape the playful performance more effectively. 16 As we have hopefully demonstrated in this book, such efforts at integration can be greatly facilitated by detailed knowledge about the development and evolution of play in useful lineages of animals, such as rodents.

Certainly, the example of the leaping monkeys shows that not all the actions performed during play can be resolved by any one theory that posits play experience as a means of calibration. Similarly, if play is self-rewarding, our current knowledge fails to explain why some actions should be performed while others are not. For the time being, then, these jumps are among the many actions that we see performed by playing animals for which we can do nothing more than shrug our shoulders and enjoy the performance.

ENDNOTES

Preface

2. The utilitarian view of play can be seen in Plato’s Laws, one of the earliest writings on the subject (1975). In modern times, this view is also evident in the theories of Maria Montessori (1967), which are still heavily endorsed by educators.
4. Hughes, 1999; Scarlett et al., 2005.
5. Groos, 1898.
10. Of course, for those researchers, like ourselves, who have taken on a long-term approach to the study of play, these fluctuations in its interest have been felt directly. Over the past three decades, we have experienced comments ranging from “why in the world would you study play?” to “you study play, how cool is that?” The ease of publishing and of obtaining research funds also tends to follow these changes in attitudes.
12. In this book, by necessity of economy, we have had to gloss over the rich
behavioral contexts may have also converged toward the same function of social assessment. This is beautifully illustrated in a recent study on ravens (Bugnyar et al., 2007). These birds gauge whether an individual can be trusted in a situation involving competition for food by using information derived from their object play. That is, individuals that share during play can also be trusted not to steal one’s hidden cache of food!


51. As pointed out by Sutton-Smith, 1997, play is ambiguous in many ways. If this is so, ambiguity may be a core feature of all play. In this instance, we specifically use the term “ambiguity” to represent the situation in play fighting where the intent of one’s partner’s actions is not always obvious. For example, one’s partner may be cheating.

Chapter 7

1. The vertebrates are actually a subphylum of the larger phylum Chordata, a group that includes the lancets and sea squirts – animals with a dorsal nerve and dorsal notochord (a cartilaginous rod that stiffens the body), but not the segmented vertebrae of the Vertebrata (Lecointre & Guyader, 2006).


3. Recall Burghardt’s development of the surplus energy theory, which identifies a number of factors that generate play-like behavior, and then transforms that into play proper (see endnote 10 in chapter 1).


5. Primates are divided into two main branches, the anthropoids (monkey-like primates) and the prosimians (pre-monkey-like primates). With the advent of cladistic taxonomy, a slightly different division has become evident – the strepsirrhines and the haplorrhines. These terms refer to the noses of the members of these respective groups. The strepsirrhines include all but one group of those previously included with the prosimians. Essentially, the strepsirrhines have a dog-like, wet nose, whereas the haplorrhines have a human-like, dry nose (Hartwig, 2006). One group of strepsirrhines, the lorisiforms, which includes pottos, lorises, and bush babies, are relatively small, nocturnal, tree-living animals with a diet that includes insects, and a social system with the least amount of social aggregation of all primates. It is the confluence of all these features that make the lorisiforms most like that which has been hypothesized to be typical of the ancestral primate condition (Nekaris & Bearder, 2006).


8. Erhlich & Musicant, 1975; Erhlich, 1977; Evans & Poole, 1983, 1984; Geist, 1981, 1982; Nevell, 1971; Paquette, 1994. Note that the loris and the bush baby belong to the same group of primates as the potto (see endnote 5).


14. A large literature exists on humor, one that is too large to do justice to it here. However, we note some of that literature as it pertains to the key features that we have mentioned in the text and from which the interested reader can explore (Abel, 1998; Azim et al., 2005; Führ, 2002; Hay, 2000; Hobday-Kusch & McVittie, 2002; Priest & Swain, 2002).

15. See Corsaro (1997) on African-American banter. There is also a rich literature on the use of ridicule in “small scale societies,” which appears designed to prevent any one individual from becoming too conceited (Boehm, 1999).


19. Fortunately, for Sergio, he moved, the next year, to a different school, where he remained for the rest of his secondary schooling. At this other, mixed-sex school, there was the occasional tough to deal with, but there did not exist that gang culture that had made the previous school so difficult.


21. Of course, there are means by which the neural activity of animals can be monitored and these could be used to determine whether the brain’s pleasure centers are activated in any particular bout of presumptive play (see Panksepp, 1998). Such methods are only feasible in highly constrained laboratory settings. Thus, for most instances of non-human animal play observed in the real world, we are not privy to the inner workings of the subjects’ brains. Rather, we have to, as best as we can, make judgments about whether the behavior fit the criteria established for deciding whether a specific behavioral sequence is playful or not (see Burghardt, 2005). Nevertheless, experimental settings and measurements can be used that allow the animal to show us whether it finds the experience pleasurable. This can be achieved
either by giving it the opportunity to escape the test enclosure or by scoring whether it is evading its partner's playful overtures rather than promoting further contact (Reinhart et al., 2006; Varlinskaya, Spear & Spear, 1999).

34. For sex differences in play and social competence, see Maccoby & Jacklin (1974) and Maccoby (1998). People with autism have impoverished social skills (White, Koenig & Scahill, 2007), and, perhaps not unrelated to the sex difference in these skills, there is a higher prevalence of autism in males. Indeed, it has been suggested that autism arises from the development of a hyper-masculine brain (Baron-Cohen, 2003).
40. For examples of variation in the boldness-timidity gradient, see Fox (1972), Francis (1990), Lyons, Price, & Moberg (1988), Mendl & Paul (1990). For examples showing that bold or timid responses in one context are consistent with responses in other contexts, see Benus, Koolhaas, & van Oortmerssen (1987), Blanchard & Blanchard (1990a), Huntingford (1990). For examples that explore some of the neural and genetic differences that underlie these differences in temperament, see Benus et al. (1991), Clarke & Boinski (1995), Cools et al. (1990), Suomi (2005).
43. Sutton-Smith & Kelly-Byrne, 1984.
44. For discussions of the role of sexual selection in humans in the differentiation of play fighting and aggression between the sexes, see Pellegrini & Archer (2005) and Pellegrini (2006).
46. Coie & Dodge, 1998. It is also worth pointing out that contrary to the practice so often applied in the past few decades of raising children's self-esteem in the belief that people are aggressive because of low self-esteem, the evidence shows that the opposite is true. Rather, people with high self-esteem, especially when it is not supported by actual ability, are the most likely to lash out violently when their self-image is challenged (Baumeister et al., 2005; Bushman & Baumeister, 1998).
47. Peterson & Flanders, 2005.
48. Burghardt & Burghardt (1972) describe such restraint in young animals.
51. Of course, while direct manipulation of these brain mechanisms is possible with rats and monkeys, it is not possible in humans. Nonetheless, judicious studies of people with neurodevelopmental disorders, such as autism, and the use of modern brain imaging technology, could provide the direct comparisons needed.

Chapter 8

2. Pellis, 1996. As an interesting aside, it worth noting that we initially noticed the counter-rotation of the lower body quite by accident. At the time, we were using rats, rather than cats, and after about 8 years of working with them, one of us, Sergio, had become allergic. During this particular experiment, Sergio was dropping the rats, upside down, in the air and Vivien was filming the trials using a high-speed camera. In order to obtain a "good" righting trial, the rat should be released once it relaxes in your hands, and to feel the rat's body more easily, it is better if one does not wear protective gloves. By the end of the session, Sergio had noticed welts on his wrists that were the result of being struck by the tails of the rats as they were righting. But how did they do that? This led us to look more closely at the video of their air righting, and, sure enough, as the rat was released, the head and neck began to turn one way and the lower body the other way, which resulted in a whip-like movement of its tail. If the rat's hindquarters had only begun to rotate after their forequarters had begun to rotate, Sergio would have been able to withdraw his hand in time and avoid being lashed by the tail (S. M. Pellis, Pellis, & Teitelbaum, 1991).


5. Our method of validation has hinged on the comparative approach, in which we first identified the key behavioral components and their rules of interaction via various descriptive techniques, then used the phylogenetic distribution of these elements across a set of related species, and finally, reconstructed the behavioral phenomenon and its distribution to see if the descriptive elements could account for all aspects of play fighting (Pellis, 2005).


9. Simpson, 1976. It should also be noted that engagement in social play, including play fighting, has been shown, in children as well as in ground squirrels, to be associated with an improved motor performance in other contexts (Bar-Haim & Bart, 2006; Nunes et al., 2004a, b).

10. Pellis & Pellis, 1997a. Patas monkeys are Old World monkeys that live in Eastern Africa, and spend most of their time foraging on the ground. They have long limbs and the build of a greyhound, and, not surprisingly, can run very fast. Given their penchant for feeding out in the open grassland, their speed is their primary defense mechanism for escaping predators.


12. Christine Reinhart, at the time of writing, was comparing the organization of play fighting in two species of monkeys, the egalitarian and easy-going Tonkean macaque, and the despotic and highly-strung Japanese macaque. Differences in temperament between species offer another avenue for understanding species differences in the form of their play fighting and other social behavior (Thierry, Iwaniuk, & Pellis, 2000; Thierry, 2004). This is an avenue that is, as yet, poorly explored in rodents.

13. Spinka, Newberry, & Bekoff (2001) predict that play should be interspersed with variable actions so as to increase the experience of unexpected consequences. But it is unclear whether this prediction should include all kinds of variation in movement, or some subset. If all, then it is not possible to distinguish this theory from others that also predict that the movements that occur in play are variable. As more detailed empirical studies become available, greater precision in predicting the kinds of variation expected by one theory versus another become possible (e.g. Petru et al., 2008).


15. For the role of intrinsic reward in psychology, see Harlow (1953) and for animal behavior, see Hughes and Duncan (1988). For the mechanisms that underlie pleasure, see Cabanac (1992).

16. Indeed, as noted a number of times in this book, the adequate integration of function and mechanism is a major task that confronts all those interested in understanding behavior and its evolution (Thierry, 2005, 2007).