The Ontogeny of Play in Rats

JAAK PANKSEPP
Department of Psychology
Bowling Green State University
Bowling Green, Ohio

Play behavior, as indicated by frequency and duration of pinning behavior, was studied in young rats between 18 and 64 days of age. The incidence of play was markedly increased by social isolation. Play increased from 18-28 days of age, peaked between 32 and 40 days of age, and gradually declined thereafter. Animals developed stable "dominance hierarchies" during the course of testing so that one animal pinned the other on the average 70% of the time. Also, "dominant" animals exhibited the longer pin durations. The data indicate that social play can be efficiently studied in the laboratory rat and, further, that one function of play may be to establish stable social relationships.

Young animals play more than old animals. Although this generalization seems self-evident, empirically derived ontogenetic functions of play are rare in the experimental literature (Bekoff, 1972; Welker, 1971). Because play behavior may be a source process for adult social competence, the systematic analysis of play behavior should provide insights into the genesis of specific adult social behaviors related to aggression, dominance, sexuality, and more general social tendencies such as gregariousness. An efficient procedure for the experimental analysis of social play in a common experimental animal, such as the laboratory rat, might be especially advantageous for promoting further work in the area.

Play among young rats has been recognized since the vivid descriptions by Small (1899), who noted that rats begin to play at about 18 days of age and that "by the twenty-fifth their whole repertory of plays was complete: running, jumping climbing, fierce sham fights (no anger ever), with biting, clawing, and pommeling, running over the mother and biting her ears, digging in corners, gnawing at the cage, sex-motions, 'picking,' licking and fondling each other" (p. 97). Although the complexity of the phenomenon may have discouraged further analysis, several additional descriptions of social play in rats have appeared in the intervening years (Baenninger, 1967; Bolles & Woods, 1964; Olioff & Stewart, 1978; Poole & Fish, 1975). In her study of behavioral development in rats, Baenninger (1967, Table VI) has summarized the elaboration of social behaviors in rats between the ages of 9 and 92 days, and has shown that most playful behaviors such as "fighting," "dominating," and "submitting" exhibit an inverted-U-shaped function with a peak at 30-36 days. In a study specifically designed to study the development of social play in rats, Müller-Schwarze (1966) observed a similar inverted-U pattern of play across age. In that study, the investigator observed paired rats for 5-hr periods and found that play increased from an average of about 200 sec to 350 sec from Days 26 to 40 and then declined gradually to zero by about 58 days of age.

Reprint requests should be sent to Dr. Jaak Panksepp, Department of Psychology, Bowling Green State University, Bowling Green, Ohio 43403, U.S.A.

Received for publication 17 March 1980
Revised for publication 16 September 1980
Developmental Psychobiology, 14(4): 327-332 (1981)

CCC 0012-1630/81/040327-06$01.00

Unfortunately, the relatively low levels of play behavior observed in most such studies (e.g., a maximum of 3% of total observation time in the Müller-Schwarze study) does not bode well for an efficient analysis of play in rats. However, social play is dramatically facilitated by prior social isolation (Panksepp, 1979), and this maneuver provides a simple procedure for amplifying the amount of play behavior, thereby permitting a behavioral assay that consists of brief observation periods.

Another difficulty in systematically studying play is the richness of the behavior that is exhibited. A procedure we have employed is to count the frequency of one objective and easily operationalized behavior that occurs repeatedly during apparent play bouts between rats, namely, "pinning." During play, rats frequently end up in this usually improbable posture of having their dorsal surface to the ground, with another animal hovering above in a "dominance" stance. Of course, some variation occurs in the exact motor posture that animals assume when pinning or being pinned, but the incidence of the behavior is unambiguous, easily scored and quantified (our interrater reliabilities have been above .90). In previous work, we have found that pinning correlates highly ($r > .80$) with other measures of play behavior in rats (Panksepp & Beatty, 1980). Also, because pinning may represent the consummatory phase of social play in rats, it may be an inherently appropriate measure for the amount of play that has transpired. Accordingly, in the present experiment we utilized a measure of pinning to study the development of social play in both socially housed and individually housed young rats. Because the behavior of each animal of a pair was monitored independently, the experiment also evaluated whether stable social relationships evolve during the course of play.

Method

Fifty-eight Long-Evans hooded rats (*Rattus norvegicus*) from 6 litters born at BGSU on 4 consecutive days were divided into pairs of littermates of like gender. All rats remained in their original home cages (41.5 × 17.5 × 21-cm wire mesh cages with wood-chip bedding) with their mothers until Day 18, when 14 pairs counterbalanced across litters and genders were rehoused individually in suspended wire cages (24.5 × 17.5 × 19-cm wire mesh; Isolated Condition). The remaining animals were rehoused in pairs in similarly constructed wire mesh cages having a 41.5 × 17.5-cm floor area (Social Condition). Of the 14 pairs of isolated animals, 9 were tested on Days 18, 20, and every 4 days thereafter through Day 64. The remaining 5 pairs ("ontogeny probes") remained in isolation without being tested until Day 40, at which time they were tested every 4th day through Day 64. Of the 15 pairs of socially housed animals, 10 pairs were tested from 18 to 64 days of age, as above, whereas the remaining 5 pairs were tested only from 40 days of age onward. In order to control for effects due to handling and time in the testing cage, all ontogeny probes were placed individually into the play chamber for 5 min during all days when play was measured in the main experimental groups between 18 and 36 days of age. In all, the study included 24 males and 34 females balanced across conditions, but because no reliable gender effects were observed, data were collapsed across this variable.

Animals were tested in a 31 × 31 × 32-cm Lucite test cage situated in a soundproof box with a 10 × 10-cm observation window. To make the test chamber "comfortable," the floor was covered with about 2 cm of wood shavings, and the only illumination was from a 25-W red light bulb mounted from the ceiling of the soundproofed box. All animals were tested at the beginning of the dark part of a 12-hr light:12-hr dark diurnal cycle.

For individual identification purposes, 1 member of each pair was painted with a solution of green food color at least 24 hr before testing. Each test lasted 5 min. The data were recorded on digital counters and electronically yoked running time meters. Behaviors recorded were the number and duration of pins for each animal and the numbers of self-grooms, mounts, and boxing postures. A pin was defined as one animal lying on its back with the other animal on top. During rough-and-tumble play, when animals rolled over each other, a pin was also recorded whenever an animal had its back to the ground. The frequency of self-grooms, mounts, and boxing postures was uniformly low (typically less than 2 counts per session), and because those measures provided no insights into the ontogeny of social play in the present study, they will not be discussed further.

Results

The animals, especially the socially deprived ones, played vigorously. These animals exhibited almost continuous social activity—chasing, pouncing, rolling over each other and pinning—broken by brief bouts of exploration, digging, and grooming. In isolated pairs, often I observed 10 pins/min during the 5-min observation period.

Reliable main effects of Age, Housing Condition and their interactions were evident (analyses of variance: p's $< .01$). Play was low at 18 days of age, but increased dramatically across the next week, with the highest levels of play occurring between 32 and 40 days of age, followed by a gradual decline. The effects of social deprivation were unambiguous: isolated animals played throughout the test sessions, whereas group-housed animals spent most of their time exploring with only occasional bouts of vigorous social interaction. Some learning may have contributed to the growth of the ontogeny curve, for isolated ontogeny probes played reliably less during the 1st test (Day 40) than animals which had received play experience from the beginning of isolation ($t = 3.5$, $df = 12$, $p < .002$). However, the absence of any difference between these groups thereafter suggests that the amount of play exhibited may largely be a consequence of intrinsic rather than learned factors. Of course, the role of accruing

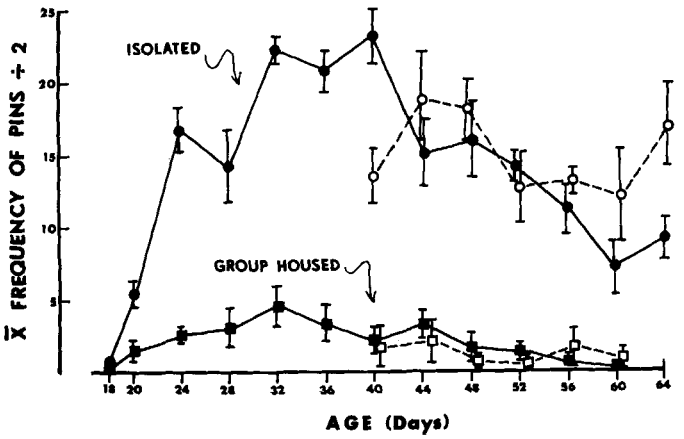

Fig. 1. The average (±SEM) number of pins per animal during 5-min observation periods in socially and individually housed rats as a function of days. The same pairs of animals were tested every 4 days. Separate groups of "ontogeny probes" were given their 1st play test on Day 40, even though they were allowed exposure to the test chamber on all previous test days.

social deprivation on the form of the curve cannot be evaluated from the present design.

To determine whether play was providing experience by which animals structure their social interaction, I analyzed the data for individual animals of each pair, the question asked being whether paired animals develop stable dominance relationships through play. The top position was assumed to indicate "dominance," and the bottom position, "submission." (The terms "dominance" and "submission" are placed within quotations to remind the reader of the limited measures of what are necessarily complex constructs.) One animal of each pair was defined as dominant by the frequency of pins exhibited on Day 44 of age. The data were averaged with reference to this arbitrarily selected "anchor-point." Only data for isolated rats were analyzed because a similar analysis for socially housed animals did not seem realistic, not only because of the infrequency of pinning but because these animals had extended opportunities to develop their dominance relationships at home when not being observed.

Stable patterns of dominance did evolve during play (Fig. 2). Initially, both animals of each pair exhibited about the same amount of pinning, but with experience, 1 animal consistently pinned more (approximately 70% of the time) than the other. A similar pattern evolved in the probe animals. During their 1st day of play, animals appeared to be equally matched, but gradually an asymmetry of "assertiveness"

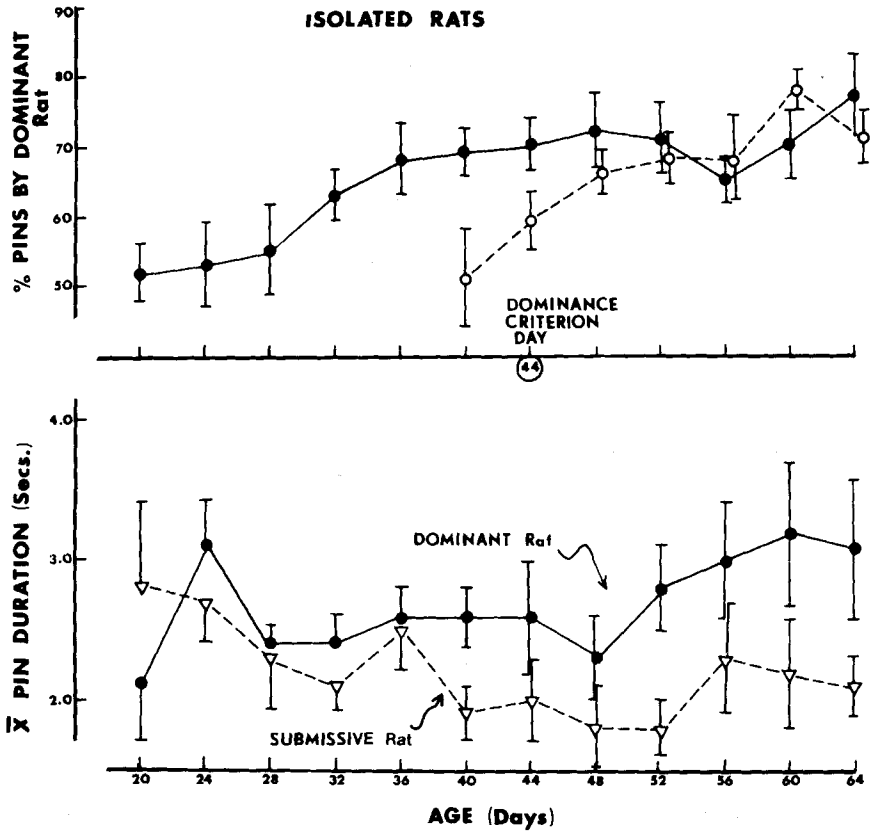

Fig. 2. The distribution of pins between socially isolated pairs. All scores were averaged with respect to a dominance determination on Day 44. The average (±SEM) pin durations for each animal are summarized in the bottom graph.

evolved. When a stable dominance pattern had developed, the average pin duration of the dominant animals was consistently longer than of the submissive animals (Fig. 2), but the measure was quite variable. On individual days, the measure only reached statistical significance on Days 40 and 52 (t's > 2.8, $df = 8$, p's $< .05$). When the data for all animals (including probes) were averaged for the last 4 days of testing, the average ($\pm$SEM) pin duration of submissive animals was $2.1 \pm .2$ sec and of dominant animals 3.0 ± 3 sec ($t = 3.75$, $df = 13$, $p < .005$).

Although dominance, once established, tended to remain stable for the duration of testing, several animals appeared to reverse status during the 1st half of the experiment. Data from these animals suggest that reversals of dominance relationships are heralded by decreases in play. For instance, on Day 24, 1 animal of a pair pinned the other 19 times vs 14 times for the other. On Day 28, these animals played very little and exhibited no pins (accounting for the dip in the curve that day in Fig. 1). On Day 32, the dominance status of these animals was reversed with the respective pin scores for these animals being 16 and 25, and 6 and 32 on the subsequent days. Until the end of testing, the initially submissive rat remained dominant as defined by frequency of pinning.

Although body weight was not a certain predictor of dominance (lighter animals sometimes prevailed over heavier ones), as a group the dominant animals weighed more than submissive ones (e.g. on Day 40, the dominant group weighed 126 ± 13g and the submissive animals 117 ± 17g. On Day 60, their respective weights were 230 ± 41 and 212 ± 41 g (t's > 2.3, p's $< .025$, with t-test for paired comparisons, but not reliably different with an independent groups comparison).

Discussion

Play, as indicated by pinning, can be readily measured and quantified in the young laboratory rat, especially if the animals are maintained in social isolation. Our observations are in good accord with those of Small (1899) and Poole and Fish (1975); through social deprivation, we can amplify play so that brief observation periods suffice for a substantial sample of the behavior. The inverted-U-shaped ontogeny curve is generally similar to the one presented by Müller-Schwarze (1966) and to the incidence of social behavior as described by Baenninger (1966). A relatively stable plateau of high play activity occurs between 24 and 52 days of age with a peak at 32-40 days. The stability of the behavior bodes well for further systematic analyses of this behavior in rats.

Although social play in rats may have many ramifications for adult competence, the most characteristic aspect of rat play was its assertiveness, though it appeared to lack the hallmarks of true aggression. Basically, the play appeared "friendly." Biting attack and sustained defensiveness were never observed. Thus, the present observations are in agreement with those of Small (1899; p. 99), who said, "in all the tussling and fighting during play I have not seen a single rat lose his temper and 'go at it in earnest.'"

These data bear out the reasonable suggestion of many investigators that social play is the mechanism by which the young find their place in the existing social structure of a group. Although the present experiment with isolated rats may not have any semblance to a normal social situation, the animals did develop a knowledge of each other, as indicated by the distribution of pinning.

In 1899 Small was able to say that "the subject of play is so new and so little exploited from the inductive side, that some important results ought to follow a careful study of the ontogenetic development of the play activities" (p. 98). The passage of 80 years has not brought us much closer to understanding the basic

functions and underlying mechanisms of play. Perhaps the use of pinning, as an objective and easily quantified measure of social play between rats, can help us make substantial progress in understanding the many facets of this fascinating behavior.

Notes

This research was supported by NIMH Research Scientist Development Award MH-00086. I wish to acknowledge the technical assistance of R. Yancher.

References

Baenninger, L. P. (1967). Comparison of behavioural development in socially isolated and grouped rats. *Anim. Behav., 15*:312-323.

Bekoff, M. (1972). The development of social interaction, play and metacommunication in mammals: An ethological perspective. *Q. Rev. Biol., 47*:412-434.

Bolles, R. C., and Woods. P. J. (1964). The ontogeny of behavior in the albino rat. *Anim. Behav., 12*:427-441.

Müller-Schwarze, D. (1966). Experimente zur Triebspezifität des Säugetierspeils. *Naturwissenschaften, 53*:137-138.

Olioff, M., and Stewart, J. (1978). Sex differences in the play behavior of prepubescent rats. *Physiol. Behav., 20*:113-115.

Panksepp, J. (1979). The regulation of play: Neurochemical controls. *Neurosci. Abst., 5*:172.

Panksepp, and Beatty, W. W. (1980). Social deprivation and play rats. *Behav. Biol., 30:197-206.*

Poole, T. B., and Fish, J. (1976). An investigation of playful behaviour in *Rattus norvegicus* and *Mus musculus* (Mammalia). *J. Zool., 175:61-71.*

Small, W. S. (1899). Notes on the psychic development of the young white rat. *Am. J. Psychol., 11*:80-100.

Welker, W. I. (1971). Ontogeny of play and exploratory behaviors: A definition of problems and a search for new conceptual solutions. In H. Moltz (ed.), *The Ontogeny of Behavior.* New York: Academic Press. Pp. 171-228.