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Weaning of Young Rats: Effect of Time on Behavior

Abstract. *Male rats were weaned on the 15th, 16th, 17th, 25th, and 30th day of postnatal life. The rate of elaboration of the conditioned reflex at 8 months of age and the stability of the memory trace at 12 months were studied. Compared with rats weaned at 30 days of age, those weaned on day 15 elaborated the conditioned reflex much more slowly and the memory trace was less firm. Rats weaned on days 16 and 17 elaborated the conditioned reflex more quickly than rats weaned on day 15 but more slowly than those weaned on day 30. In all groups the memory trace showed the same stability and was significantly firmer than in rats weaned on day 15. The higher nervous activity of rats weaned at the age of 25 days more nearly resembles that of rats weaned at 15 days than of those weaned later.*

The time of weaning is considered to be the change from the diet of breast milk to that of the adult mammal. This change is usually gradual, and it is difficult to find out when the young animal has partaken of breast milk for the last time. We depend mostly on indirect findings (*1*) or experiences of breeders. Kon (*2*) and Leschi (*3*) cite the 21st day as the limit; Denenberg *et al.* (*4*, *5*) suggest that it is days 21 and 25. According to breeders this period starts between the 3rd and 4th weeks of life.

We have studied the relation of the higher nervous activity (the speed of the elaboration of the conditioned reflex and the stability of the memory trace) in adult rats to the length of the suckling period. We found that premature weaning on day 15 significantly influences the higher nervous activity throughout life (*6*, *7*).

We used male Wistar rats. The first group were those weaned on day 15, that is, at the time when the young ones can survive without the mother. The second group was weaned on day 16, the third on day 17, the fourth on day 25, and the fifth on day 30; in our laboratories we call day 30 the time of normal weaning. Each experimental group, consisting of male littermates, had 10 subjects. At the age of 8 months the conditioned reflex was elaborated. The rats were adapted in advance to the experimental situation until they learned to take in the whole daily dose of water only, in the conditioning box, within a few minutes. The conditioning stimulus was the sound of an electric bell; the unconditioned stimulus, the offering of water. During one experiment conditioned and unconditioned stimuli were administered ten times at intervals of 2 minutes. All animals were trained until they reached the acquisition criterion. A conditioned reflex was considered fully elaborated when the rat always (that is, in all ten trials of one experiment) showed the right reaction—drinking water from a tube under electrical registration. Between the conditioned stimuli alternating current was passed through the water which prevented the rats from drinking. At the age of 12 months the stability of the memory trace was tested by determining the percentage of positive responses in single groups of rats in the first session after a 4-month interval. We then studied how many conditioned and unconditioned stimuli are required for a complete reelaboration of the old conditioned reflex by comparing the rate of the first elaboration of the conditioned reflex and its reelaboration.

We tested the rate of the elaboration of the conditioned reflex in 8-month-old rats. Conditioned reflex was elaborated most quickly in rats weaned at 30 days of age. Rats weaned earlier than this elaborated the conditioned reflex more slowly. The slowest elaboration of the conditioned reflex occurred in rats weaned on day 15. The difference between day 15 and day 30 is statistically significant ($P \leq .001$). Rats weaned on days 16 and 17 elaborated the conditioned reflex at an intermediate time, and those weaned on day 25 can be placed between the groups

Table. 1 Rate of elaboration of conditioned reflex determined by the average number of connections of the conditioned and unconditioned stimuli (± the mean error). The statistical significance between the different groups of animals is also given; n.s., not significant.

Day of weaning	Number of connections	Significance ($P \leq$) between groups weaned on day			
		15	16	17	25
15	98.2±8.6				
16	74.6±5.8	.05			
17	62.0±8.3	.01	n.s.		
25	77.3±9.3	n.s.	n.s.	n.s.	
30	43.3±4.1	.001	.001	.05	.01

Table 2. Stability of the memory trace determined by the average of positive responses to the conditioned reflex (± the mean error). The statistical significance between the different groups is given; n.s., not significant.

Day of weaning	Responses (%)	Significance ($P \leq$) between groups weaned on day			
		15	16	17	25
15	15.0 ± 5.2				
16	60.0 ± 9.8	.001			
17	74.0 ± 8.8	.001	n.s.		
25	40.9 ± 10.1	.05	n.s.	.05	
30	76.7 ± 9.0	.001	n.s.	n.s.	.05

Table 3. Reelaboration of the conditioned reflex. The number of connections of the conditioned reflex is expressed as 100 percent (I); number of connections during reelaboration (II) is expressed as a percentage, calculated on the basis of the difference between I and II; n.s., not significant.

Day of weaning	I (%)	II (%)	$P \leq$
15	100	72.7	n.s.
16	100	28.5	.003
17	100	28.5	.003
25	100	30.0	.003
30	100	40.0	.01

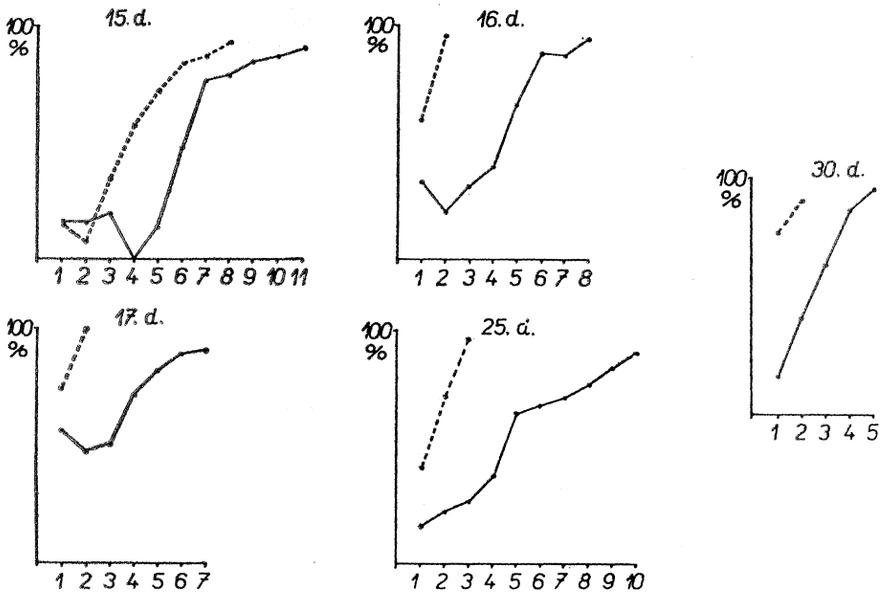

Fig. 1. Course of the elaboration of the conditioned reflex (solid line) and of the re-elaboration of the conditioned reflex (broken line) in rats weaned on the 15th, 16th, 17th, 25th, and 30th day after birth. Abscissa: number of sessions; ordinate: average of positive responses during one session.

with the slowest and the intermediate rates of elaboration (Table 1).

In testing for stability of the memory trace we found that the percentage of positive responses during the first session after an interval of 4 months is highest in rats weaned on days 30, 17, and 16. Compared with the memory trace in rats weaned at 30 days of age (Table 2), statistically fewer positive responses were found in rats weaned on day 25 ($P \leq .05$), and least evidence of the memory trace was found in rats weaned on day 15 ($P \leq .003$).

For the reelaboration of the old conditioned reflex, rats weaned at the age of 30, 25, 17, and 16 days need fewer connections of conditioned and unconditioned stimuli than they did during the first elaboration. Rats weaned at the age of 15 days need practically the same number of connections of the conditioned and unconditioned stimuli for the reelaboration as they did for the first elaboration (Table 3 and Fig. 1).

Sudden change from a diet of breast milk to one of high carbohydrates on day 15 led to essential changes in reactions of the nervous system—the conditioned reflexes were elaborated more slowly and the memory trace was very weak (*6*, *7*). Therefore we consider weaning on the 15th day of life to be premature. By this criterion weaning performed on day 15 is most unfavorable and weaning on day 30 is optimum. The removal of the mother from the young on days 16, 17, and 25 is also premature.

According to Scott's theory (*8*), the development of the individual, as well as the postnatal ontogenesis, goes on in so-called critical periods; Denenberg (*9*) demonstrates that we can presume the existence of critical periods in development by the fact that the same impulse applied at different ages evokes a different response. According to this criterion, weaning of rats in various stages of the suckling period can aid in determining both the optimal time of weaning for development of the highest functions of the brain and the decisive periods for this development—before the 30th day of life and at or after the 30th day.

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Free-Ranging Rhesus Monkeys: Age and Sex Differences in Individual Activity Patterns

Abstract. *Two hundred thirty of the feral rhesus monkeys on Cayo Santiago were observed individually for postural adjustments, locomotor behavior, manipulation, and other nonsocial activities. Both form and frequency of activity were influenced strongly by age; sex differences were minimal. Most activities decreased with age, but head movements, presumably reflecting visual scanning, were more frequent in adults.*

Free-ranging rhesus monkeys have been studied rather extensively with regard to patterns of social and sexual behavior (*1*, *2*). Although many investigators have made reference to the general activity of monkeys, no formal data have been available on the frequency with which individuals, not actively involved in social acts, assume different postures and engage in various behaviors such as locomotion, climbing, manipulation of inanimate objects, and self-grooming. Data of this type on individuals are useful for comparison with studies of the motor behavior of monkeys maintained in more restricted settings, that is, in laboratory cages or compounds; it can also serve as a base line for estimating the effect of ecological and social factors on activity in the field. This is a report of a survey of approximately two-thirds of the monkeys on Cayo Santiago, Puerto Rico. Special attention was paid to the influence of age and sex on selected postures and activity patterns.

The study was made during February and March 1964. At that time the colony on Cayo Santiago consisted of approximately 368 rhesus monkeys (*Macaca mulatta*) grouped in six distinct bands ranging in size from over 100 members to less than 20 (*2*). Over the 2-month period, 230 individually identified monkeys were observed on one or more occasions for 2-minute periods (eight consecutive 15-second intervals), and the incidence of various postures and activities was recorded on a checklist. Since only the occurrence or nonoccurrence of a given posture or activity was scored for each 15-second interval, the maximum possible score per observation period was 8 for any one behavior category. The categories of the checklist were (i) postures: quadrupedal, bipedal, seated, lying (on chest, back, or side) and (ii) ac-