Escape behavior in neonatal rats[1]

JAMES R. MISANIN, Z. MICHAEL NAGY,[2] and E. MAX WEISS,[3] Susquehanna University, Selingrove, Pa. 17870

Rats, 5-11 days old, showed improved performance over trials on a shock-escape task, as indicated by a decrease in competing responses. While rate of improvement did not differ at these ages, the number of competing responses did, being indirectly related to age. This finding plus the observation that Ss exhibited a definite direction preference suggest that the recorded response may be an inborn reaction to aversive stimulation. In contrast to competing responses, speed on trials without competing responses remained constant during training, suggesting that Ss move at an asymptotic speed for their level of maturation and a fixed level of motivation.

Although a large number of studies have been concerned with the behavioral effects of stimulation during infancy, only a small portion of these has been concerned with the immediate consequences of such stimulation, the majority investigating the effects of early experience on behavior in later stages of development. Studies concerned with the immediate behavioral effects of early stimulation in rats have shown that responses can be classically conditioned within 1-8 h of parturition (e.g., Caldwell & Werboff, 1962). Convincing evidence for successful learning of an instrumental nature in rats under 10 days of age is, however, virtually nonexistent, although some evidence for the early emergence of such behavior is provided by Goldman & Tobach (1967). These investigators found performance of an avoidance response in rats to improve over successive sessions from 10 to 12 days of age. Since an avoidance response is typically acquired after the establishment of an escape response, it is possible that escape behavior appears in rats under 10 days of age. The present experiment explored this possibility.

METHOD

The Ss were 20 male and 20 female albino rats of the Wistar strain, randomly selected from litters born in the Susquehanna University animal colony. Five male and five female rats at each of four age levels (5, 7, 9, and 11 days) were given shock-escape training in a 25 x 6 x 10 cm aluminum straight alley with a grid floor. The grids were 1-mm-diam stainless steel rods, mounted in Plexiglas at 2-mm intervals. The grids ran parallel with the alley, a floor feature that facilitated forward movement in the neonatal rat. A removable door, 5 cm from one end of the alley, formed the startbox. Each trial began with removal of the door and the simultaneous onset of .1-mA scrambled ac shock (Harvard Instrument Co., Model 3121). The trial and shock ended when S reached the goal end of the alley. At shock offset, S was immediately removed from the alley and replaced in the startbox. This procedure was followed for 25 trials, with an intertrial interval of 45 sec. The time it took S to traverse the alley was recorded to the nearest .1 sec and was regarded as response latency. Observation of the first few animals trained at each age level suggested an additional measure be taken—the number of competing responses during a trial. A competing response was defined as a 180-deg turn in a direction away from the goal. Thus, this measure was obtained for the last seven animals trained at each age level. The direction (right-left) of each turn was also recorded.

RESULTS AND DISCUSSION

The mean reciprocal latency for each block of five trials was determined for individual Ss. An analysis for a three-factor experiment, with repeated measures on one factor, was performed on these data with age, sex, and trial blocks being the factors under consideration. The analysis showed age and trial blocks to be significant factors ($F = 23.45$, $df = 3/32$, $p < .001$, and $F = 8.25$, $df = 4/128$, $p < .001$, respectively). The interaction of these factors was also significant ($F = 2.00$, $df = 12/128$, $p < .05$). No other significant effects were obtained. Since sex neither had a significant main effect nor significantly interacted with the other factors, it was ignored in the graphical representation of the data (Fig. 1). Individual comparisons between speeds on the first and last block of trials at each age were consistent with Fig. 1, i.e., the speed of the 9- and 11-day Ss increased from the first to the last trial block (Fs = 24.33 and 12.47, respectively, $df = 4/128$), whereas the speeds of the 5- and 7-day Ss remained constant. The increase in speed in the older Ss and the constancy in the younger Ss account for the significant Age by Trial Block interaction, although the failure of the 7- and 9-day-olds to differ on the first trial block is also an influencing factor.

The mean competing responses per five-trial block of the seven Ss in each age group are shown in Fig. 2. A 4 by 5 analysis of variance (sex ignored) performed on these data showed both age and trial block to be significant factors; there was, however, no significant interaction of these variables ($F = 6.90$, $df = 3/24$, $p < .005$; $F = 11.64$, $df = 4/96$, $p < .001$; $F = 1.17$, $df = 12/96$, respectively). Since the Age by Trial Block interaction was not significant, direct tests on main effects were made using the Duncan range procedure. These tests, made at the .05 significance level, showed the 11-day Ss to differ from all others, the 9-day Ss to differ from the 5-day Ss, and the 7- and 5-day Ss not to differ from each
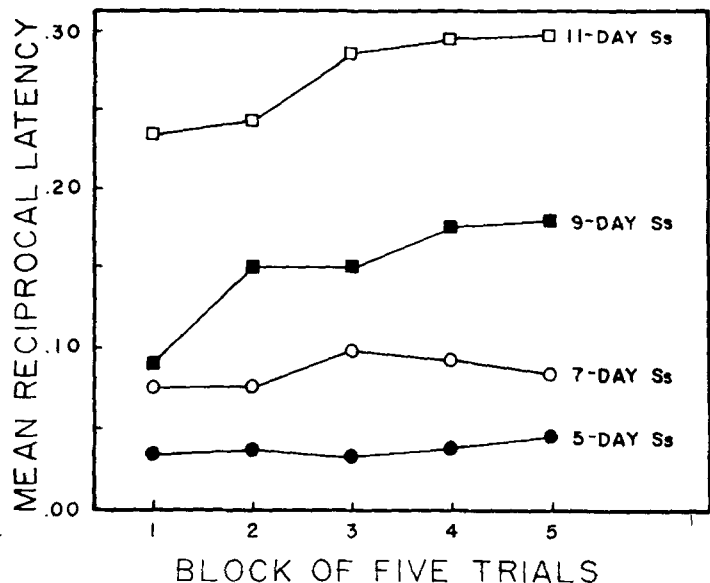

Fig. 1. Mean reciprocal latencies per five-trial block as a function of age.
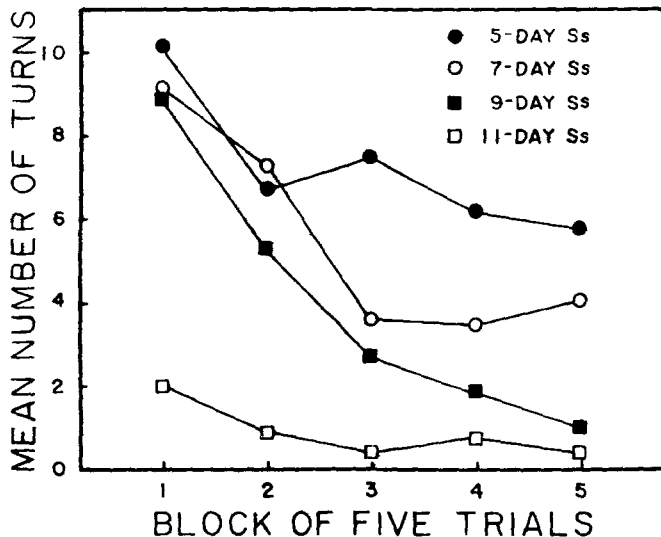
Fig. 2. Mean number of turns per five-trial block as a function of age.

other. Blocks of Trials 2-5 differed from the first trial block, and Blocks 4 and 5 differed from the second; Blocks 3, 4, and 5 did not differ.

The fact that competing responses decreased in the 5- and 7-day Ss while speeds remained constant suggests a possible fatigue factor operating in these Ss. To check this possibility, speeds on trials in which no competing responses occurred were averaged for the first (Trials 1-12) and second (Trials 14-25) halves of the training session and analyzed as a 2 by 4 design with repeated measures (sex ignored). Only age was found to be a relevant factor ($F = 19.64$, $df = 3/24$, $p < .001$). Thus, if fatigue is operating in the 5- and 7-day Ss, it may also be operating in the older Ss, but it is not of sufficient degree to lead to a reduction in speed over the session at any age level. The fact that speeds remained constant on trials without competing responses also suggests that neither habituation nor sensitization to shock can reasonably account for the diminution in competing responses during the session. It suggests, furthermore, that on such trials Ss were moving at asymptotic speeds for their level of maturation and the given level of motivation. This finding may be true for animals of any age in a shock-escape situation; comparable data for adult animals are not available.

A puzzling finding is that the speeds of the 5- and 7-day-olds did not increase

(Fig. 1) in spite of a diminution in competing responses (Fig. 2) over the session. Perhaps, Ss of these ages were learning to be immobile in order to reduce shock (cf. Campbell & Teghtsoonian, 1958); the poorer motor ability of these Ss may, in fact, be more conducive to learning an immobile response than to learning a locomotor response.

The competing response recorded is of additional interest. The first response to shock in the majority of the Ss was to make this 180-deg turn. This initial reaction was, moreover, more prevalent at the younger age levels. All of the 5-day-olds whose competing responses were recorded displayed this behavior, while five of the 7- and 9-day-olds and only three of the 11-day-olds reacted in this way. Bolles & Woods (1964) noted such a response in neonatal rats that fell or were dragged from the nest and suggested that warmth emanating from the mother might be the reinforcing stimulus for the reaction. Gard et al (1967), however, noted a similar reaction (pivoting) to aversive stimuli in the absence of any apparent reinforcing stimulus. It may be that this response is a wired-in reaction to aversive situations. On the other hand, in the present situation it may simply be that shock to the forepaws is more painful than it is to the hindpaws and that S is turning in the direction of the least painful stimulation (cf. Fowler & Miller, 1963). In any case, it appears that only continuing

neural development in this early life stage allows for the gradual inhibition of this response and the concomitant emergence of alternative behaviors. Trials on which these 180-deg turns did not occur averaged 4.3, 12.0, 14.6, and 22.1 for the 5-, 7-, 9-, and 11-day-old Ss, respectively. These differences were significant at the .001 level ($F = 12.90$, $df = 3/24$).

Another intersting aspect of the competing response was its direction. Most Ss tended to persist in turning in the direction of their first turn. While this tendency was not strong and did not differ as a function of age, a chi-square analysis indicated that the number of Ss displaying such a preference was significantly greater than chance ($p < .01$). The percentage of turns in the direction of the first turn for those Ss with such a preference averaged 70.3. Whether this is a learned or innate preference cannot be determined from the present data; there was, however, no change in preference from the first to the second half of the session, indicating that learning in the situation played little, if any, role.

REFERENCES

BOLLES, R. C., & WOODS, P. J. The ontogeny of behavior in the albino rat. Animal Behaviour, 1964, 12, 427-441.
CAMPBELL, B. A., & TEGHTSOONIAN, R. Electrical and behavioral effects of different types of shock stimuli on the rat. Journal of Comparative & Physiological Psychology, 1958, 51, 185-192.
CALDWELL, D. F., & WERBOFF, J. Classical conditioning in newborn rats. Science, 1962, 136, 1118-1119.
FOWLER, H., & MILLER, N. E. Facilitation and inhibition of runway performances by hind- and forepaw shock of various intensities. Journal of Comparative & Physiological Psychology, 1963, 56, 801-805.
GARD, C., HÅRD, R., LARSSON, K., & PETERSSON, V. The relationship between sensory stimulation and gross motor behavior during the postnatal development in the rat. Animal Behaviour, 1967, 15, 563-567.
GOLDMAN, P. S., & TOBACH, E. Behavior modification in infant rats. Animal Behaviour, 1967, 15, 559-562.

NOTES

2. Reprint requests should be sent to the first or second author.
3. Now at Dickinson School of Law.