Presurgical handling and exploratory behavior of rats with septal lesions

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Behavioral effects of septal lesions are altered by presurgical history of the experimental animal. We examined the interactions between presurgical handling of young adult rats and subsequent septal lesions on postsurgical exploratory behavior in an open field. Sixty-day-old male rats were either handled twice daily for 20 days prior to surgery or left undisturbed during this period. All rats were tested in a dimly illuminated open field for 5 min on both Days 10 and 11 following surgery. Surgical control rats stood up more frequently and crossed more squares than those with septal lesions; these measures also indicated that handled animals were more active than their nonhandled counterparts. However, only nonhandled control rats displayed a marked decrease on these measures from Day 1 to Day 2 of testing. The behavioral effects of septal lesions are differentially influenced by the specifics of the presurgical manipulations and the test situation.

The presurgical history of the experimental animal is an important determinant of the behavioral effects of septal lesions. For example, we found that various aspects of the "septal syndrome" can be altered by: environmental/social enrichment (Donovick, Burright, & Swidler, 1973), the interaction between environment/social enrichment and genotype (Donovick, Burright, Fuller, & Branson, 1975), dietary enhancement (Donovick, Burright, & Bentsen, 1975), dietary deletion (Bengeloun, Burright, & Donovanick, 1976), and age-related factors in general (Bengeloun, Burright, & Donovanick, 1977). Thus, the typical septal lesion effects on water consumption, reactivity to taste, exploratory behavior, and performance on a passive avoidance task observed in young naive animals are alterable by presurgical manipulations.

Donovick et al. (1973) included periodic handling of animals in their presurgical environmental/social enrichment conditions. It is well documented that handling per se, either during early developmental stages (e.g., Denenberg, 1964; Levine, 1962; Williams, Bailey, & Lee, 1975) or later in life (e.g., Doty, 1968; Doty & O'Hare, 1966), can be an important determinant of subsequent behavior displayed by intact as well as septal-damaged animals. Indeed, both pre- and post-surgical handling may reduce the relatively transient "hyperemotionality" component of the so-called septal syndrome (cf. Fried, 1973).

Studies with nonlesioned animals have indicated that the behaviors affected include exploration. Such data led Levine (1962) to suggest that handling may exert its influence on emotional reactivity (cf. Archer, 1973).

Exploratory behaviors are altered by septal lesions (cf. Fried, 1972). Furthermore, both early handling (Levine, 1962) and septal lesions (Usher, Birmingham,

& Kasper, 1967) lead to changes in adrenal function which have been employed often as an index of emotionality (Ader, 1969). It thus seemed appropriate to examine the effects of presurgical handling on the behavior of septal and control rats in the exploration of an open field.

METHOD

Subjects

Subjects were 28 male Sprague-Dawley-derived albino rats (Taconic Farms, Germantown, New York) weighing approximately 200 g upon receipt from the supplier. Rats were weighed and assigned to the handled or nonhandled group. They were placed in individual standard metal laboratory rat cages. The vivarium was maintained on an 8:00 a.m. to 8:00 p.m. light cycle with temperatures between 21°C and 24°C. All animals had unlimited access to Purina Rat Chow and water.

Apparatus

The open field was constructed of wood and had dimensions of 56 x 46 x 45 cm high. It was painted white and was dimly illuminated by an overhead light (approximately 5 fc). The floor was divided into four quadrants (each 23 x 28 cm).

Procedure

Two days after receipt, each rat in the handled group was actively handled and petted by the experimenter during two 5-min daily sessions for 20 consecutive days. During the 20-day presurgical period, animals in the nonhandled group were left undisturbed. All animals were again weighed at the end of the 20-day period and, within handling conditions, assigned to matched surgical treatment groups on the basis of body weight. Half of each treatment group received bilateral electrolytic lesions of the septal area, using procedures previously described elsewhere (Donovick et al., 1973); the other half underwent surgical control procedures consisting of a scalp incision and drilling of the skull. Following surgery, all subjects were left undisturbed throughout a 10-day recovery period. At the end of the recovery period following surgery, each animal was placed in the middle of the open field for 5 min on

each of 2 consecutive test days. Behaviors recorded were number of squares traversed, number of stand-ups on hind feet, and number of fecal boli.

Histology

Upon completion of the experiment, all animals were overdosed with sodium pentobarbital and perfused intracardially with isotonic saline followed by 10% Formalin. Brains with lesions were fixed in 10% Formalin for at least 7 days, after which frozen tissue technique was used to section the brain. The sections were 80 μ m thick, and every other section throughout the lesion was stained with a metachromatic stain for nuclear and fiber regions (Donovick, 1974) and examined microscopically to determine the extent of damage.

Three-way 2 by 2 by 2 unweighted-means repeated-measures analyses of variance [lesion (L) by handling (H) by days (D)] were performed on each of the three dependent measures to assess overall differences among the groups as well as any differential changes in behavior from the first to the second test days. The four groups ranged in size from five to seven subjects.

RESULTS

Histology

For all animals used in data analysis, microscopic examination revealed that rats with septal lesions had received large bilateral damage resembling previously illustrated lesions (Donovick et al., 1973). The general pattern of the lesions was complete bilateral destruction of the medial and lateral nuclei of the precommissural septum, extending from the hippocampus pars anterior, posteriorly to the crossing of the anterior commissure. Although medial nucleus damage was complete in all cases, some unilateral sparing of the lateral septal nucleus was observed in several cases. The behavioral data of such animals was consistent with that of rats with larger lesions. Damage was not observed in the overlying corpus callosum, neocortex, or in the preoptic nuclei or nucleus accumbens of any septal animals included in data analysis.

Three lesioned animals failed to meet the above described histological criterion necessary for inclusion in our data analyses. These lesions were either unilateral in nature, sparing major portions of the medial nucleus or included extensive incursions into surrounding structures. Thus, data analysis did not include these three animals.

Open-Field Data

As can be seen in Figure 1 (upper panel), control animals crossed more quadrants of the field than those with septal lesions (L: $F = 35.9$, $df = 1/21$, $p < .001$). Further, handled animals were generally somewhat more active on this measure than were nonhandled rats (H: $F = 3.5$, $df = 1/21$, $p < .10$). Interestingly, however, the behavior of nonhandled control animals clearly changed across the 2 days of testing, while the square-crossing activity of the other three groups remained relatively stable from Day 1 to Day 2. Thus, handled septals were more active than their nonhandled counterparts on both days, while unhandled control animals were more

Figure 1. Open-field behavior across 2 days as a function of presurgical handling and septal lesions.

active than handled controls on Day 1 but less active than their handled counterparts on Day 2 (L, H, D: $F = 6.41$, $df = 1/21$, $p < .05$). All other within-subjects effects were also statistically significant beyond the $p = .05$ level in this analysis of square crossings.

An analysis of mean number of stand-ups exhibited during each of the 2 test days is shown in the middle panel of Figure 1. Control animals stood up more than did rats with septal lesions (L: $F = 29.7$, $df = 1/21$, $p < .001$), and handled animals again tended to be more active than their nonhandled counterparts on this measure (H: $F = 4.2$, $df = 1/21$, $p < .10$). While the pattern of stand-ups is quite similar to that seen in terms of square crossings, the L by H by D interaction did not reach statistical significance. However, all other within-subjects effects were reliably ($p < .05$) present for the stand-up measure.

The lower panel of Figure 1 illustrates the mean number of boli excreted on the 2 test days. The boli count was higher in the nonhandled animals compared with their handled counterparts (H: $F = 20.3$, $df = 1/21$, $p < .001$); the handling effect was more marked in septals than in controls insofar as total boli were concerned (L by H: $F = 5.31$, $df = 1/21$, $p < .05$). In fact, while excretion rate was higher in the nonhandled lesioned animals than in the nonhandled controls, those

rats that had been handled prior to receiving septal lesions defecated less than any of the other groups tested. Further, we can see that across the 2 days the nonhandled animals increased frequency of excretion, whereas handled rats defecated the same amount on both test days ($H, D: F = 4.75, df = 1/21, p < .05$). The only other statistically significant effect in this boli count analysis was the within-subjects main effect of days.

DISCUSSION

Previous work done by Levine (1962) has indicated the behavioral importance of stimulation in the form of handling during infancy. In the present experiment, animals were handled beginning at the age of 60 days. This is clearly beyond the "critical period" indicated by Levine. Nonetheless, behavior in the open field was altered by this presurgical manipulation such that the pattern of exploration across days was differentially affected in lesioned and control animals. In the present experiment, animals with septal lesions were more active than their nonhandled counterparts on both days of testing; this pattern of behavior was seen in the generally more active control animals only on the second day of testing. In this context, the effects of handling appear to have differentially influenced the boli count in the two surgical groups as well; that is, nonhandled septals defecated more than did handled septals on both days of testing, but this pattern did not emerge until Day 2 for the surgical control rats. Thus, differential adaptation to the testing procedure seen in nonhandled controls when compared to either lesion group is comparable to that previously reported by Donovan and Wakeman (1969). Apparently, the presurgical handling of young adult male rats differentially altered the pattern of habituation displayed by square-crossing and stand-up measures more markedly in control animals than in septal-damaged rats. But the pattern of habituation as reflected in the boli counts was similar, regardless of brain damage.

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