

The effects of prenatal injections of adrenalin chloride and d-amphetamine sulfate on subsequent emotionality and ulcer-proneness of offspring

R. W. Bell, R. R. Drucker / and A. B. Woodruff
NORTHERN ILLINOIS UNIVERSITY

Abstract

Twenty pregnant female rats were each given one injection of (1) 1.5cc/kg body weight of a 1:1000 solution of adrenalin chloride, (2) 3.0mg/kg body weight of a 0.9mg/1.0cc solution of d-amphetamine sulfate, or (3) 1.5cc/kg body weight of distilled water. Injections were administered intraperitoneally either between 6 and 9 days post-conception, during which time the fetal stomach and intestine are developing, or between 12 and 15 days post-conception. Following normal rearing, offspring were subjected to immobilization stress, with pre- and post-measures of emotionality, following which they were assayed for ulcers. The results indicate modified emotionality as a function of the prenatal treatments, and a significantly higher frequency of ulceration in those Ss whose mothers had been injected with adrenalin at the time of the fetal stomach development.

Introduction

Prenatal stress, chemical or environmental, can modify offspring, both structurally (e.g. Thompson & Goldenberg, 1962) and behaviorally (e.g. Thompson, 1957), with the timing of the stress being an important variable (e.g. Hartel & Hartel, 1960). Montagu (1962, p. 201) has suggested that the effect (e.g. ulcers) of mild prenatal stress, such as maternal emotionality, may appear only under appropriate environmental conditions. Thompson (1957) has suggested that the exogenous administration of certain chemicals may mimic prenatal maternal emotionality.

It is hypothesized that prenatal injections of adrenalin chloride or d-amphetamine sulfate will produce a greater tendency towards ulcers in the offspring; that the injections administered when the fetal gut is developing will have the most drastic effect; and that emotionality will be similarly affected.

Subjects

Twenty litters of Long-Evans Hooded rats, totaling 144 individuals, served as Ss.

Apparatus and Materials

The pregnant female rats received prenatal injections of:² (1) 1.5cc/kg body weight of a 1:1000 solution of adrenalin chloride; (2) 3.0mg/kg body weight of a 0.9mg/1.0cc solution of d-amphetamine sulfate; or (3) 1.5cc/kg body weight of distilled water. The drugs provide a comparison of two sympathetic activators and a placebo solution. Behaviorally, adrenalin chloride appears to be a brief, relatively intense stressor, while

d-amphetamine sulfate produces lesser, more prolonged, reactions.

Emotionality was measured in an open field apparatus consisting of a 48 in by 48 in high wooden box. The interior was painted flat black, with the floor divided into 4-in squares by white lines. A 200 watt bulb with metal reflector was suspended 28 in above the center of the field.

Procedure

Prenatal and rearing conditions. Twenty females were mated with experienced male breeders. All pairs remained together for four days. The females received one injection intraperitoneally of the adrenalin chloride, d-amphetamine, or distilled water on either the 10th or 16th day after being placed with a male partner. Calculations back from the day of parturition indicated that the injections had been administered either between 6 and 9 days (while the fetal gut was developing) or between 12 and 15 days after conception.

All offspring were reared without extrinsic handling until 45 days of age.

Testing of offspring. At 45 days of age each S was weighed, and placed in the open field for one 2-min. trial. The number of squares crossed was used as an index of emotionality. Following the open field trial, Ss were immobilized³ for a period of 48 hr. during which they were also food and water deprived, and then again tested in the open field. Immobilization was accomplished by bandaging each S in gauze, placing it on its back on a foam rubber padded board, and taping it to the floor of a cage. This procedure permitted slight head movements, but no other bodily movements.

Following the second open field trial, 12 Ss from each of the six treatment groups were selected for sacrifice and examination for ulcers. The selection of Ss for this analysis was based on scores from trial one in the open field, with the six highest and six lowest scores from each experimental condition being selected. Ss were killed with a blow on the head, the stomach and duodenum removed and opened, and the presence or absence of ulcers determined.

Results and Discussion

Body weight did not vary significantly among the six experimental groups. Activity in the open field was analyzed as a 3 (Drugs) x 2 (Timing of injection) x 2 (Trials) analysis of variance. Table 1 shows the major findings of the open field data. Ss whose mothers were

Table 1

Mean activity (no. of squares entered) in the open field

Treatment	Trials	
	1	2
Adrenalin, 6-9 days	48.67	29.61
Adrenalin, 12-15 days	49.83	20.28
D-amphetamine, 6-9 days	41.68	22.68
D-amphetamine, 12-15 days	37.12	17.58
Water, 6-9 days	53.06	40.06
Water, 12-15 days	56.41	32.29

injected with d-amphetamine appear to be the least active (most emotional), with the Ss born to water-injected mothers displaying the greatest activity (least emotional) ($p = .05$). For all groups the second trial, following the immobilization stress, showed lowered activity scores ($p = .01$). Ss injected between 12 and 15 days post-conception tended to show greater decrements in activity between trials than did the earlier-injected Ss ($p = .01$).

The number of ulcerative Ss per group of 12 varied from 2 to 7. A series of Fisher Exact Probability Tests established one significant difference among the frequencies, with those Ss whose mothers were injected with adrenalin at the time the fetal stomach and intestine were developing exhibiting a greater frequency of ulcers (7) than did Ss whose mothers had been injected with water ($p = .05$).

Adrenalin, injected prenatally, appears to have had its greatest effect in facilitating a specific physiological breakdown following the immobilization stress, while d-amphetamine had its greatest effect on behavioral manifestations of emotionality. The greater ulceration in those Ss whose mothers were injected while the fetal stomach and intestine were developing suggests possible specific changes, structural or chemical, in

these organs. This is consistent with other reports of specific structural deficiencies produced prenatally (e.g. Thompson & Goldenberg, 1962).

Although exogenous injections of chemicals may not reproduce exactly the internal state accompanying strong emotionality, it is certain that neurohumoral agents are accompaniment of emotional stress (Gellhorn et al, 1941), and it is unlikely that the permeability of the placenta differs between endogenous and exogenous sources of hormones. The present study and similar research suggest that the variability of stress reactions of individuals may, in part, be explicable in terms of prenatal humoral events, possibly initiated by differential maternal emotionality.

References

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Notes

1. Present address: Department of Psychology, University of Waterloo, Ontario.
2. Dosage levels of drugs were adapted from those used in similar investigations (Thompson & Goldenberg, 1962; Ross & Schnitzer, 1963) based upon a pilot study, which showed that adrenalin produces much more intense effects than d-amphetamine when equated in dosage.
3. For detailed information concerning the effects of immobilization stress on ulceration, see Sines (1959).

Abstract

MOYER, K. E. (Carnegie Tech.). Effect of ACTH on open field behavior, avoidance, startle, and food and water consumption. *J. genet. Psychol.*, in press.—86 naive albino male rats were divided into four experimental and two control groups. Experimental groups received 10 days of ACTH injections in the following doses: Group I, 0.125 USP/100 gm; Group II, 0.25 USP/100 gm; Group III, 0.5 USP/100 gm; Group IV, 1.0 USP/100 gm; Group V received control gelatin. Group VI was a normal control. Ss had food and water ad lib 23 hr. a day throughout the experiment and consumption measures were taken. On the fifth through the

ninth injection days Ss were tested for open field activity and defecation. On Day 10 the Ss startle response to shot and shock was tested. After the termination of injections, Ss were tested for acquisition and extinction of an avoidance response. Ss were also weighed before and after the injection series. Although clinical studies strongly indicate that differences among the groups might be found, analysis of variance of the various measures indicated that there were no significant differences among the groups on any of the dependent variables. (Prepublication copies are available upon request to the author.)