The effect of auditory restriction during pregnancy on offspring survival¹

SEYMOUR LEVINE² AND DONALD L. KING³

STANFORD UNIVERSITY SCHOOL OF MEDICINE

Abstract

The results of this study indicate significantly greater infant mortality when females were reared following pregnancy under conditions of marked deprivation of auditory stimuli. The major affects were attributable to the effects of auditory restriction during pregnancy; however, a significant postnatal effect of auditory restriction was found in the weight of the offspring at 21 days of age.

Introduction

Within the general framework of the effects of infantile stimulation on adult behavior, numerous procedures have been instituted to attempt to manipulate the environment of neonatal rats. In a recent pilot experiment, it was hypothesized that severe reduction of ambient stimulation during infancy would result in striking changes in the adult behavior of the neonatal rat required to develop in a stimulus-deprived environment. It was hoped that if a procedure which involved severe restriction of the environment could be initiated, it would be possible to determine just what amount of stimulus input at what times during the animals development would be sufficient to overcome these effects. However, in the course of these experiments, an unexpected but interesting result was obtained.

During the initial experiments, pregnant females were placed in an isolated soundproof chamber as a condition of severe neonatal deprivation. The females were placed into the sound box when pregnant, and remained in this environment until 21 days after they littered. Although the number of pups initially dropped was not counted, of the three females placed in the box, two litters were about half the size usually obtained with these Ss, and with one, all of the offspring were destroyed. Insofar as infant mortality in our existing colony is so small, this result was quite unexpected. In order to verify, four more females were made pregnant and placed in the sound box. Twenty-one days after birth the litter sizes were 0, 3, 5 and 10. These litter sizes were again well below those of rats reared in the animal colony.

In view of these findings the focus of the study was shifted to an investigation of the effects of reduced auditory stimulation during pregnancy and nursing on survival of the offspring. The design of the experiment was a 2 by 2 factorial, with one group being placed in the sound chamber at the time of pregnancy and remaining there throughout gestation, parturition and nursing (the silence-silence group). A second group was

mated in the colony room and remained in the colony room throughout the same period of time (the colony-colony group). Two additional groups were formed, with one placed in the sound box during gestation and removed to the colony room for parturition and rearing (the silence-colony group); the other following the reverse procedure (the colony-silence group).

Subjects

The Ss were 28 virgin female Sprague-Dawleys.

Apparatus

The sound box was the Industrial Acoustics Corporation Model M401A sound chamber. The sound attenuation in this chamber is extremely high so that relatively little ambient noise, except that occurring in the sound box itself, was available. Variations in light stimulation were somewhat curtailed, since the chamber did not admit outside light. The light cycle was 12 hr. on and 12 hr. off, kept identical with that of the animal colony room. It should be noted, however, that the sound box Ss were exposed to some changes in the environment, albeit minimal, when the food and water were changed. During pregnancy, water was given about every three days, and food was sufficient to last throughout the period of gestation. During rearing, water changes became more frequent, being daily in the last 10 days of the experiment.

Procedure

The onset of pregnancy was determined by the presence of sperm in the vaginal smears. The silence-silence and silence-colony females were placed in the sound box immediately upon pregnancy. Animals in the colony-silence condition were put in the sound box on the twentieth day of gestation.

On the day of birth, the number of offspring were counted. Counting was done in a manner designed to disturb the mother and litter as little as possible. At 21 days after birth the number of surviving offspring was determined and the weight of the offspring was obtained.

Results

For each mother, the proportion of offspring that died to the number counted on the day of birth was calculated. The arc sine transformation was used on the proportion so that a more normal distribution of scores would be used in the analysis of variance. A 2 by 2 unweighted mean analysis of variance was performed. An individual score was the transformed proportion of dead to born offspring for a single mother. The analysis of variance indicated that a significant

prenatal effect was obtained ($p < .02$). The transformed proportion of offspring dying to born for each cell was 1.03 for the silence-silence condition, .68 for the silence-colony condition, .34 for the colony-silence group, and .15 for the colony-colony group. The mean proportion under the silence-silence group is significantly different from the means for the colony-silence and colony-colony conditions ($p < .10$, $p < .02$, respectively). The mean proportion for the silence-colony condition is significantly different from the mean for the colony-colony condition ($p < .05$).

For the analysis of the weight data, the same 2 by 2 analysis of variance was used. A single cell entry was the mean litter weight of a single litter, insofar as the weights of the offspring within a given litter are not independent. Although there was no significant pregnancy effect on weight, the analysis of variance indicated a significant *postnatal* effect ($p < .05$). The means of the mean litter weights were 46.8 gm for the silence-silence condition, 47.4 gm for the colony-silence condition, 48.9 gm for the silence-colony group, and 50.8 gm for the colony-colony group. The only significant difference between cell means is between the silence-silence and colony-colony groups ($p < .05$).

Discussion

The main result of this study is that reduced sensory stimulation during pregnancy increases infant mortality. This effect could be a result of (1) changing the mother's physiological status which, in turn, affects

the prenatal and postnatal status of the offspring; and (2) permanently affecting the maternal behavior of the mother. Since direct measures of maternal behavior were not taken in this study, it is difficult to choose between one or the other of these two hypotheses. It has been demonstrated in other investigations, however, that sensory restriction of fairly long duration leads to a disorganization of intellectual and emotional behavior (Thompson & Heron, 1954; Melzack, 1954; Melzack & Scott, 1957). Thus, the more reasonable of explanations is that as a function of sensory restriction during the prenatal period, maternal behavior is subsequently disorganized, leading to a poorer probability of survival in the offspring.

References

- Melzack, R. The genesis of emotional behavior: an experimental study of the dog. *J. comp. physiol. Psychol.*, 1954, 47, 166-168.
- Melzack, R., & Scott, T. H. The effects of early experience on the response to pain. *J. comp. physiol. Psychol.*, 1957, 50, 155-161.
- Thompson, W. R., & Heron, W. The effects of restricting early experiences on the problem solving capacity of dogs. *Canad. J. Psychol.*, 1954, 8, 17-31.

Notes

1. This research was supported by NIH Grant MH 07435 and the Leslie Fund, Chicago, Illinois.
2. Department of Psychiatry. Research Career Development Award 5-K3-19,936-02.
3. Department of Psychology.