Spreading cortical depression and the maternal behavior of guinea pigs*

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Female guinea pigs and their young were observed for 9 h over Days 2-26 postpartum. Prior to 50% of the observation periods, the females had 20% KCl applied to the neocortex through double cannulae. The results show that cortical deactivation does not modify the female's nursing time, responsiveness to its offspring, or weight gain of the piglets.

The limbic system has been implicated in the control of innate species-specific behavior (MacLean, 1957). Stamm (1955), Wilsoncroft (1962), and Slotnick (1964) all report disturbances in the maternal behavior of rats following lesions in the system. Stamm (1955), for example, reports that lesions in the cingulate and retrosplenial cortex produce disturbances in nest building, retrieval of pups, and removal of pups and nest from aversive stimuli (heat, draft from a fan). The neocortex has also been involved in the control of maternal behavior. Beach (1937) and Stone (1938) report that neocortical lesions disrupt rat maternal behavior; in general, the larger the lesion, the greater the deficit.

The present study examines further the changes in maternal behavior following loss of cortical tissue. More specifically, the study examines the effects of spreading cortical depression (Leão, 1944) on the maternal behavior of guinea pigs.

MAINTENANCE

The Ss were nine primiparous guinea pigs from a genetically heterogeneous stock reared in our laboratory. On the day of parturition, the females ranged in age from 9 to 14 months. Guinea pig chow and water were always available. The females were housed individually in metal cages (16 x 24 in.). The laboratory was on a natural light cycle with testing taking place from August 15 to November 22, 1970.

PROCEDURE

Approximately 10 weeks prior to testing, each female had a sexually active male placed in its home cage. Of 15 guinea pigs paired, 11 became pregnant and had offspring. Two to 5 weeks following pairing, the females, under pentobarbital anesthesia supplemented with ether and atropine sulphate (1/100 grain), had double cannulae implanted bilaterally. The

cannulae rested on the dura overlying the occipital-parietal region of the neocortex. The outer tube of each cannula was a 22-ga hypodermic needle, 1.2 mm long; the removable inner tube was a 27-ga needle, 1.9 mm long and bent into a right angle. The cannulae were secured to the skull with acrylic resin.

Following 6-7 weeks of cohabitation, the males were removed. On the day of birth (Day 1), females with three or four offspring had their litter sizes reduced to two; litter size has been shown to be a factor in the control of guinea pig nursing behavior (Stern & Bronner, 1970). Two females had only one pup each and were eliminated from study.

Starting on Day 2 and every 3 days thereafter until Day 26, the females and their offspring were observed in their home cages for 1 h. On Day 2, five females had 20% KCl placed in their cannulae, while four females had saline applied to the neocortex; the applications were reversed for each subsequent observation period. By Day 26, therefore, each female had been observed for a total of 9 h, every other time with KCl. The cannulae were filled 10 min prior to observation; the E did not know which females had been given KCl or saline.

During each observation period, the E recorded total nursing time and the number of positive and negative responses. A positive response is defined as any behavior by the female that increases the likelihood of nursing. For example, the act of standing upright giving the pups access to the teats is scored as positive. A negative response is defined as any behavior that terminates or reduces the probability of nursing. If the piglets are nursing at the start of an observation period and the female walks away, it will have a positive score of 0 and a negative score of 1. An approach by the pups to which the female does not actively respond is not scored, even if it leads to nursing. Finally, on Day 1 and every 3 days thereafter until Day 25, the piglets

were weighed.

In order to determine whether the application of KCl was indeed producing spreading cortical depression, four of the females were tested in an open field following completion of the experiment. Cortical deactivation is known to reduce general locomotion activity (Grossman, 1967). The field was made of wood, measured 4 x 4 ft, and had 16 grids on the floor. Prior to testing, each female was given a minimum of 3 h exposure to the field. The females were given two 10-min sessions in the field, one time with saline and one time with 20% KCl. During each session, the number of grids crossed was recorded.

RESULTS

Temporary cortical deactivation did not limit nursing time in guinea pigs. If the data are divided into halves (KCl vs saline), there are no significant differences for the nine females as a whole or for the animals taken individually. The statistics employed were Wilcoxon z tests for matched samples. Figure 1 shows the percentages of nursing time under the two conditions for the 9 h of observation.

Table 1 shows the mean number of positive and negative responses exhibited by the females. There was a decrease in positive and an increase in negative responding for both conditions. In other words, the probability of a female allowing its young to suckle was independent of cortical deactivation.

Finally, spreading cortical depression did not affect the weight of the young. A comparison of the piglets in this study with the eight pups from

Fig. 1. Percentage of nursing time under KCl (hatched bar) and saline (clear bar) over the days of observation.

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Table 1
Mean Number of Positive and Negative Responses (See Text for Definitions)
Exhibited by the Females Under KCl and Saline

		Days								
		2	5	8	11	14	17	20	23	26
Positive	KCl	3	3.2	2.8	1.7	0.8	1.5	0	2	0.8
	Saline	3	3.2	2.8	1.6	1.2	0.4	1.2	0.6	0
Negative	KCl	0	0	0	0	0.4	0.7	1.4	2.7	1.8
	Saline	0	0	0	0.2	0.5	1.2	0.7	1.2	1.2

the two animal litters in a previous study (Stern, 1971) reveals no significant difference in weight (Mann-Whitney U test; Fig. 2).

Fig. 2. Weights of the piglets in this study and those from a previous study (Stern, 1971) for Days 1-25 postpartum.

During the open-field tests with KCl, the females crossed an average of 13.5 grids (range: 2-19); with saline, this figure was 27.0 (range: 15-43) ($p < .05$). It appears, therefore, that the application procedure was producing spreading cortical depression.

DISCUSSION

Spreading cortical depression does not limit maternal behavior in guinea pigs. The present report demonstrates no difference between KCl and saline with respect to nursing time or the response of the female to its offspring. Previous work in our laboratory has shown that early social isolation of the female (Stern & Hoffman, 1970) or ovariectomy following parturition (Stern & Siepierski, in preparation) does not alter maternal behavior either.

Shortly after birth, piglets are ambulatory. Because of this, the typical pattern of nursing in the guinea pig is for the young to approach the mother who either permits or prevents suckling. To prevent suckling during the early days of nursing, the female simply walks away; by Week 3 the female kicks the young away. Perhaps, then, the failure of the above

mentioned perturbations to alter maternal behavior is due to the female's role being a passive one; the female merely allows the young to nurse. Research is presently under way to determine factors that increase the female's tendency to nurse.

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