LEARNING ABILITY OF ORPHAN FOALS, OF NORMAL FOALS AND OF THEIR MOTHERS

Katherine A. Houpt, Mary S. Parsons and Harold F. Hintz

Cornell University, Ithaca, NY 14853

Summary
The maze learning ability of six pony foals that had been weaned at birth was compared to that of six foals reared normally. The foals' learning ability was also compared to their mothers' learning ability at the same task; the correct turn in a single choice point maze. The maze learning test was conducted when the foals were 6 to 8 mo old and after the mothered foals had been weaned. There was no significant difference between the ability of orphaned (weaned at birth) and mothered foals in their ability to learn to turn left (6 ± .7 and 5.1 ± .9 trials, respectively) or to learn the reversal, to turn right (6.7 ± .6 and 6.2 ± .6 trials, respectively). The orphan foals spent significantly more time in the maze in their first exposure to it than the mothered foals (184 ± 42 vs 55 ± 15 s, Mann Whitney U = 7, P<.05). The mothers of the foals (n = 11) learned to turn left as rapidly as the foals (5.9 ± .7 trials), but they were slower to learn to turn right (9.8 ± 1.4 vs 6.4 ± .4 trials, Mann Whitney U = 33, P<.05), indicating that the younger horses learned more rapidly. There was no correlation between the trials to criteria of the mare and those of her foal, but there was a significant negative correlation between rank in trials to criteria and age (r = -.65, P<.05) when data from the mare and foal trials were combined. The dominance hierarchy of the mares was determined using a paired feeding test in which two horses competed for one bucket of feed. Although there was no correlation between rank in the hierarchy and maze learning ability, there was a correlation between body weight and rank in the hierarchy (r = .7, P<.05). This may indicate either that heavier horses are likely to be dominant or that horses high in dominance gain more weight. Maternal deprivation did not appear to seriously retard learning of a simple maze by foals, although the orphans moved more slowly initially. The lack of maternal influence on learning is also reflected in the lack of correlation between the mare's learning ability and that of her foal. Young horses appear to learn more rapidly than older horses.

(Key Words: Horse, Learning, Dominance, Pony, Weaning, Maze.)

Introduction
A foal sometimes must be reared artificially either because its mother has died or because the mare is unable or unwilling to properly nurse the foal. In addition to those instances in which the foal must be bottle reared, there are times when the owner may decide to wean at an early age in order to transport the mare to be rebred without subjecting the foal to the stress of travel or the danger of infectious disease on another farm. Because artificial rearing may have an effect on the foal's later behavior, we wished to determine if the lack of normal maternal care had any effect on the young horse's learning ability or potential to be trained.

The learning ability of adult (Gardner, 1937; Haag et al., 1980; Mader and Price, 1980) and juvenile (Kratzer et al., 1977; Fiske and Potter, 1979) horses has been studied, but the learning ability of artificially reared horses has not been compared with that of those normally reared. Experiments with other species such as dogs (Melzack and Scott, 1957) and cats (Seitz, 1959) indicate that learning ability might be impaired. Learning ability may alter a horse's trainability. If artificially reared horses learn more slowly, the information would be of considerable economic interest to the horse industry, because horses must be trained in order to be used for racing, driving or pleasure riding.
Materials and Methods

Two groups of six grade Shetland-type pony foals were used. The foals in one group, the orphans (n = 6), were taken from their mothers at birth and reared artificially. They were never allowed to suckle. The orphan foals were bottle fed for 48 h and then gradually shifted to a hay and grain diet. The second group, the mothered foals (n = 6), remained with their dams and were nursed by them. The details of the method of rearing the orphan foals have been given elsewhere (Burton et al., 1981). The maze learning experiments began when the foals were 6 to 8 mo old and 1 mo after the mothered foals were weaned. Both groups were fed a complete pelleted feed. The foals were weighed at 14 wk of age. Two of the orphan foals and three of the mothered foals were colts. The mother of one of the mothered foals died when the foal was 3 mo old. All the other mares (n = 11) were available for testing. They were weighed at the time of testing. Age was determined from inspection of their teeth.

The design of the maze was similar to that described by Kratzer et al. (1977). The ponies had to choose between a right side and a left side escape, one of which could be blocked by a partition. A bucket of the pony's accustomed feed was placed approximately 1 m from the exit of the maze as a positive reinforcement. The ponies, both mares and foals, were fed morning (0800 h) and evening (1500 h). Two maze learning trials were conducted per day just before the evening feeding. Therefore, the ponies had been deprived of food for approximately 7 h. The order of testing was randomized, but those ponies that were performing a task different from the majority (i.e., turning left while others were turning right) were tested last. The study was divided into three phases. The first phase (trials 1 to 4 on the first 2 d) was to observe side preference. For the first four trials (training trials) the maze was open, allowing escape with either a left or right sided choice. The side preference of each pony on each of these training trials was recorded. In the second phase, the ability of the ponies to learn to turn left was measured. Starting with the fifth test (third day) the partition was used to block right side escape. When the pony correctly chose the left side for three consecutive trials, it was considered to have reached "criterion" or learned to turn left. Thereupon, the partition was moved for the particular pony to block left side escape, and the third phase of the study, measurement of the pony's ability to learn to turn right, began. The same learning criterion, three correct choices in a row, was applied to right side escape. Latency, time spent in the maze from the moment the pony crossed the threshold of the maze until the last hind foot was placed outside the maze, and errors (incorrect choices) were recorded.

The ponies were allowed to correct an error, that is, if they initially chose the wrong side, they could retrace their steps and take the correct turn and obtain the food reward. The only punishment for making the incorrect choice was a delay in obtaining food. If the pony did not complete the maze in 5 min it was led through the exit of the maze and given a latency score of 300 s.

All of the surviving mares (n = 11) and six of the foals (orphaned = 4; mothered = 2) were tested for social dominance. The six other foals had been euthanized as part of another study. Each of the mares was tested with every other mare, for a total of 55 pairings. Each foal was paired with the five other foals, for a total of 15 pairings. The ponies were tested before their regular evening feeding. One bucket of grain was made available to the two ponies for 10 min. The pony that controlled the bucket for most of the test was considered to be dominant. The details of the method of dominance testing have been given by Houpt et al. (1978).

The Mann Whitney U test (Siegel, 1956) was used to compare the times and the trials to criterion between orphan and mothered foals, between colts and fillies, between mares and foals, between the reversal indexes, reversal index =
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\frac{\text{trials to criterion to turn right (reversal)}}{\text{trials to criterion to turn left (original)}}
\]
of mares and foals, and between the reversal indexes of orphaned and mothered foals. The percentage side preference on the first five trials (four training trials and first trial when right side was blocked) was compared with 50% preference (Davis, 1962). Spearman rank order correlations were calculated between 1) trials to criteria for mares and trials to criteria for foals, 2) age and trials to criteria for mares, 3) age and trials to criteria of foals, 4) between age for all the ponies and trials to criteria, 5) weight and trials to criteria for mares, 6) weight and
Figure 1. Maze learning in orphan and mothered pony foals. The orphan foals are represented by the open column and the mothered foals by the cross hatched columns. The graph on the left, "trials to criteria," indicates the number of trials needed to learn to turn left on three successive trials and the number of trials needed to learn the reverse, to turn right on three successive trials. The graph on the right illustrates the total time spent in the maze during the trials to criteria for both groups of ponies. Time for each trial was that elapsed from the moment the pony crossed the threshold of the entrance to the maze until the last hind foot was placed outside the exit.

Results and Discussion

In the training trials and the first learning trial, the ponies showed a right side escape preference. In 73% of the trials, the mares turned right (P<.05). The foals were more variable than the adults; in 60% of the trials, the foals turned right (P>.05). Grzimek (1949a) has also noted "handedness" in horses, that is, the horses he studied also showed a right side preference both in pawing and in lead taken on a straight path. In this study, those ponies that had an initial left side preference did not learn to turn left faster than those that initially turned right.

There was no significant difference in the maze learning ability of orphaned and mothered foals. The least number of trials in which a foal could learn was three. The mothered foals learned to turn left, the first task taught, in 5.1 ± .2 trials; orphan foals learned in 6 ± .7 trials. The mothered foals learned the reverse task, turning right, in 6.2 ± .6 trials; the orphans learned in 6.7 ± .6 trials (figure 1). Although the orphan foals took no more trials to learn than their normally reared controls, they took longer to walk through the maze on the first training trial when both sides of the maze were open (orphaned = 184 ± 42 s, mothered = 55 ± 15 s, U = 7, P<.05). On subsequent trials they were insignificantly slower than the normal foals (mean time for trials to criteria = 42 ± 10 s/trial for orphaned; 27 ± 4 s/trial for mothered foals; U = 20, P>.05). Orphans, but not the mothered foals, traversed the maze more quickly with time (orphaned, r = .95, t = 4.47, P<.05; mothered, r = .8, t = 1.1, P>.05). The slower exploration of a novel environment is similar to that observed in early weaned cats and dogs (Melzack and Scott, 1957; Seitz, 1959). It is interesting to note that there have been informal observations that early weaned foals do not race well.

In contrast to early weaned dogs (Melzack and Scott, 1957) and cats (Seitz, 1959), which perform poorly in learning tasks, orphaned foals are not impaired in their ability to learn a
simple maze. There are several possible explanations for these differences among species in the effects of early weaning. One species may be more susceptible to the adverse effects of artificial rearing than another. Precocial animals such as horses may be less affected than altricial animals such as cats. The most likely explanation, however, is differences in experimental methods among the studies. The cats and dogs were isolated from conspecifics, as well as being weaned early. In addition, the tasks imposed were different. The dogs were learning to avoid pain, and the cats were learning to make a visual discrimination for a food reward, while the foals in this study were learning to follow a certain route for a food reward. Species differences in effects of early weaning on visual acuity and (or) motor function might also affect the results. Perhaps, if the task had been more complicated or difficult, differences between foals might have been found.

The mothers of the foals learned the initial task in as few trials as their offspring, but were slower to learn the reverse task. The mares learned the left turn in 5.9 ± 0.7 trials. They took significantly more trials (9.8 ± 1.4, U = 25, P < 0.04) to learn the reversal. The mares were more variable than the foals; the standard deviation was larger (t = 2.81, P < 0.05). The foals took significantly fewer trials (6.4 ± 0.4) to reach criteria than the mares (U = 33, P < 0.05).

The reversal index or ratio of the number of trials or errors to criterion on the original learning discrimination has been suggested as a measure of learning ability that is relatively independent of task difficulty. For most animals the index is greater than one, indicating that it is more difficult to learn the reversal than the original task (Hinde, 1970). The reversal index was 1.2 ± 0.2 for the orphan foals, 1.2 ± 0.02 for the mothered foals and 1.7 ± 0.2 for the mares. There is a possibility that the opportunity to eat was more rewarding for the foals than for the mares, but that would be a difficult hypothesis to test. All were equally food deprived. The offspring of mothers that learned in a small number of trials did not necessarily learn in a small number of trials. There was no significant correlation between the trials to criteria for the mare and the trials to criteria for the foal, whether learning to turn left, learning to turn right or total trials to criteria were compared.

The age, weight, dominance rank, time/trial, and trials to criteria of the mares, as well as the

<table>
<thead>
<tr>
<th>Mare</th>
<th>Weight, kg</th>
<th>Age, yr</th>
<th>Trials to criteria</th>
<th>Status</th>
<th>Mean trials/trial</th>
<th>Dominance rank</th>
<th>Trials to criteria</th>
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<tr>
<td>283</td>
<td>24.9</td>
<td>3</td>
<td>12</td>
<td>orphan</td>
<td>6</td>
<td>25</td>
<td>1.2 ± 0.2</td>
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<tr>
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<td>4</td>
<td>15</td>
<td>orphan</td>
<td>13</td>
<td>15</td>
<td>1.2 ± 0.02</td>
</tr>
<tr>
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<td>32</td>
<td>12</td>
<td>1.2 ± 0.2</td>
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trials to criteria, time/trial, body weight and dominance rank of the foals are presented in table 1. There was a correlation \( r = .65, P < .05 \) between age of the foals and trials to criteria, but not between age of the mare and her trials to criteria. Therefore, immature horses may tend to learn a maze faster than adult horses. This tentative conclusion is supported by other studies on horses. Mader and Price (1980) studied visual discrimination in Quarterhorses and Thoroughbreds and also found that trainability was negatively correlated with age. The present study extends their observation to another learning situation, maze learning, and to another type of equid, grade ponies. Kratzer (1969) found that younger pigs also learned to avoid shock in fewer trials than older pigs. A similar trend has been noted in rats (Denenberg and Kline, 1958). Although the foals learned in fewer trials than their mothers, they spent significantly more time in the maze (foals = 36 ± 5 s; mares = 13.2 ± 2 s, \( U = 32, P < .05 \)). The mares may have failed to learn because they reached food very quickly despite their errors.

There was no correlation between body weight and age of the foals or the mares, but there was a significant positive correlation between body weight and rank of the mares in the hierarchy \( r = .7, P < .05 \). A positive relationship may indicate that larger horses are dominant or that dominant horses have more access to food and, therefore, gain more weight. The cause and effect relationship of social dominance and weight has not yet been determined. Previous studies of equine dominance hierarchies have indicated a tendency for heavier horses to be dominant (Grzimek, 1949b; Montgomery, 1957; Houpt et al., 1978). It is difficult to measure learning ability without building a maze or operant conditioning device or using painful stimuli. It is easier to determine dominance and it would, therefore, be helpful to be able to predict learning ability by measuring social dominance. Unfortunately, social dominance does not appear to predict learning ability. Haag et al. (1980) and Mader and Price (1980) have also observed that there was no correlation between rank in the dominance hierarchy and learning ability.

The results on social dominance in the foals must be considered tentative because they were obtained on a small number of animals before a stable hierarchy would have been expected to form (Grzimek, 1949b). Nevertheless, it is interesting to note that the mothered foals were dominant in the same order as their mothers, but the orphan foals were not. In a previous study of normally reared horses, the offspring of dominant mares were found to rank high in dominance among their own age group (Houpt and Wolski, 1980). These results suggest, but do not prove, that horses may learn to dominate rather than inherit the tendency. This hypothesis should be rigorously tested with large numbers of cross-fostered or orphan horses.

In conclusion, it would appear that lack of normal maternal care does not adversely affect the maze learning ability of foals. The orphan foals initially moved through the maze more slowly, but made no more errors than mothered foals. Age does seem to be an important factor in equine learning, because adult mares were more variable and made significantly more errors—that is, took more trials to learn a simple reversal—than their foals. There was no correlation between the time and trials to criteria of the mare and that of her offspring. Rank in a social dominance order was not related to maze learning ability, but heavier mares tended to be socially dominant. These studies of learning ability of horses should be extended to other breeds and more complex tasks.

Literature Cited


