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EFFECT OF MILK ON THE MAINTENANCE OF SUCKING BEHAVIOR IN KITTENS FROM BIRTH TO SIX MONTHS[1]

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From birth to 6 mo. the milk received for sucking was manipulated by permitting five kittens, the milk-sucking group, to suck at a lactating cat, and five, the dry-sucking group, to suck at a nonlactating cat which was anesthetized. All kittens were fed by using a stomach-loading technique. The dry-sucking group spent as much time sucking as the milk-sucking group during the first 3 wk, but sucked increasingly less thereafter, though they continued to suck some throughout the 6 mo. At no time did the dry-sucking group initiate sucking less often than the milk-sucking group, suggesting that the effect of milk was mainly in prolonging sucking episodes. These results suggest that neither the acquired drive nor the unlearned oral drive hypothesis is adequate to explain sucking. Observations regarding playing, sleeping, nuzzling, and nipple grasping are also reported.

Sucking occurs so frequently and persistently outside of the feeding situation that it has seldom been considered merely a feeding behavior. Broader conceptions attempting to explain both the nutritive and nonnutritive aspects of sucking have generally been preferred (McKee & Honzik, 1964; Ross, Fisher, & King, 1957). Two of the more influential of these agree in considering sucking the expression of a drive, but differ as to whether the drive is unlearned (Levy, 1934) or acquired (Davis, Sears, Miller, & Brodbeck, 1948).

According to the acquired drive hypothesis, sucking acquires its drive properties through its close association with the primary drive reduction provided by the milk normally accompanying it. This suggests that food reward is a necessary condition for acquisition of the drive. Although some sucking might occur at birth, it would not be expected to continue unless accompanied by food reward. Since to date this hypothesis has not been tested directly, the present experiment is designed to investigate the extent to which the development and maintenance of sucking depends on the milk, or food reward, normally obtained by sucking.

The acquired drive hypothesis has received its strongest support from a study by Davis et al. (1948) with human babies, and from a replication and extension of this study by Benjamin (1961) with infant monkeys. The research design of both studies, however, permitted only an indirect test of the hypothesis in that food reward and sucking experience were not treated as separate variables. In both studies, the opportunity to associate sucking with food reward was manipulated by varying the opportunity to suck, rather than by varying the occurrence of food reward. Starting at birth, some infants were fed by drinking from a cup and others by sucking. For the cup-fed infants, this effectively restricted association of sucking with food reward, but it also restricted experience with sucking itself. Thus, although the cup-fed infants generally exhibited lower levels of nonnutritive sucking, it is not clear whether this was caused by their lack of association

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of sucking with food reward, or their lack of experience with sucking per se.

That other variables besides milk may determine early sucking behavior is strongly suggested by the common observation that sucking levels are relatively high in the first days of life, even before milk is forthcoming. Given a situation in which sucking initially occurs at a high level, such as the sucking situation normal for a given species, repeated sucking experience may in itself act as a determinant of sucking behavior. Thus, the present experiment was designed to provide equal opportunity for sucking experience in a normal situation while varying the occurrence of food reward.

Two groups of kittens were reared from birth to 6 mo. with regular access to live female cats. For one group, the cat was lactating so that sucking produced milk in the normal manner. For the other, she was not lactating so that sucking never produced milk. These cats were only available for a certain time each day; therefore, in order to provide nourishment at the same time as controlling sucking, all kittens were fed by means of a stomach-loading technique. The sucking behavior directed toward these cats was systematically observed throughout the 6 mo. as were other items of behavior. If milk, or food reward, is necessary to the maintenance of sucking, as implied by the acquired drive hypothesis, then the group with the nonlactating cat would be expected to show little or no sucking after the first few days of life.

Method

Subjects

The subjects were 10 kittens, 5 males and 5 females, selected from the litters of 7 different females. Three different litters were represented in the group of five kittens, three males and two females, which received milk for sucking, and four different litters in the group of five kittens, two males and three females, which did not.

Procedure

Maintenance. In every case the kittens were removed from their mothers shortly after birth, before any of them had actually started nursing. The kittens were housed individually in boxes during the first 6 wk. Cloth-covered heating pads on the floors of the boxes provided the warmth necessary for maintaining them. Between the ages of 6 wk. and 6 mo. each of them was housed in an individual cage.

In order to provide proper nourishment and still control sucking experience, all kittens were fed every 4 hr. by a stomach-loading technique. The procedure followed at each feeding started with weighing the kitten. Then a tube was inserted through the mouth into the stomach and the requisite amount of Esbilac (simulated bitch's milk produced by Borden Co. for puppies and kittens) was slowly injected. The kitten's mouth was held tightly shut around the tube in order to prevent both its dislodgment and the possible occurrence of sucking movements. After this, the kitten was returned to its box and another was fed. The amount given each kitten was an average of the amount ingested at that feeding and the prior feeding by a bottle-fed littermate which was fed as much Esbilac as desired from a small nursing bottle. These bottle-fed kittens were not part of the study as such and were only used to provide an estimate of the amount of Esbilac to be injected at each feeding. When all the kittens had been fed, the genital area of each was stimulated by stroking with a soft brush in order to initiate urination and defecation.

In an attempt to keep the experimenter-produced stimulation about the same in the two groups, each kitten in one group was matched with a kitten in the other group. For each feeding, the pairs were treated similarly with respect to the amount of time the tube was left in the stomach and the overall amount of time they were held by the experimenter. Between feedings, the kittens were left alone except for occasional health checks and the administration of the experimental conditions.

When the kittens were 6 wk. old, all of these special feeding and maintenance procedures were terminated, and the kittens were moved from their boxes to cages where they were first introduced to Pablum and then to ordinary cat food. They were given generous amounts of food, milk, and water twice a day in the morning and evening so that they could eat and drink at will.

Sucking. Each day in the first 6 wk. all kittens were given an opportunity to suck for approximately 6 hr. a day. During this period, one group, which may be called the milk-sucking group, was put in a bare, rectangular screen-covered box close to the mammary region of a normal lactating female cat and allowed to suck at will. The box was relatively small, 25 × 18 × 16 in., so that it was easy for the kittens to locate the cat and initiate sucking on their own. During the same time, the other group, which may be called the dry-sucking group, was put in a similar box close to the mammary region of an adult female cat which was not lactating. This group was also allowed to suck at will, but of course no milk was forthcoming. To prevent this cat from interfering with the kittens'

attempts to suck, she was given an injection of pentobarbital sodium (.6 cc/kg) sufficient to render her immobile for most of the 6-hr. period. Thus, for both groups, the sucking stimulus situation was as close to normal as possible except that sucking produced milk for only one group. Because of scheduling difficulties, two kittens in each group did not begin these daily sucking sessions until their second day of life, though they were removed from their mothers at birth. After the kittens were 6 wk. old they were given these opportunities to suck for only 2 hr. per day, 5 days a week, at which time they were put in bare, rectangular observation cages with the appropriate female cat. These cages were small enough, 36 × 18 × 23½ in., so that it was difficult for the lactating cat to avoid the kittens. All of the sucking sessions were thus conducted in a relatively confined space so that both the milk-sucking and dry-sucking kittens could initiate sucking on their own with the minimum of aid or interference from the cats. Only by so structuring the situation would the opportunities to initiate sucking be sufficiently comparable between the two groups to permit evaluation of the effect of milk on sucking behavior.

Observation. During the first 6 wk., the daily sucking experience was initiated approximately 2 hr. before the 2:00 P.M. feeding, and it was terminated slightly before the 6:00 P.M. feeding. Again because of scheduling difficulties, this sucking experience was initiated for one dry-sucking and two milk-sucking kittens about 2 hr. before the 6:00 P.M. feeding, and it was terminated before the 10:00 P.M. feeding. Every day during this period the kittens were observed in the 2 hr. just preceding the feeding and in the first hour just after the feeding.

After 6 wk., the daily sucking opportunities, then 2 hr. in duration, were usually scheduled in the morning, and the kittens were observed during the entire period twice a week, once at the beginning and once at the end of the week. Thus, their behavior was recorded every 3 or 4 days until they were 6 mo. old.

Since it was not possible to observe and maintain both groups of five kittens during a single 6-mo. period, the kittens were reared and observed in smaller groups during a period extending over approximately 2 yr. The size of these groups was determined by a number of factors, including the availability of newborn kittens, physical limitations regarding the space and time necessary for maintaining the kittens, and mortality. Regarding the latter, roughly one-third (6/17) of the kittens started on stomach loading and one-fourth (2/8) of those started on bottle feeding died, all, save one bottle-fed kitten, within the first 2 wk. of life. (One of the remaining 11 stomach-loaded kittens was dropped from the study due to limitations of time and space.) That these deaths may well have resulted from a lack of the normal protection afforded newborn kittens by antibodies contained in the mother's milk is suggested by the fact that five of the six stomach-loaded kittens which died were in the dry-sucking condition where they would have received no antibodies. An attempt to offset this by injecting each kitten with feline serum (.5 cc) at birth and at 2-wk. intervals thereafter until they were 6 wk. old thus appears to have been only partially successful.

As a result of the aforementioned factors, the kittens were reared essentially in four different groups. Under the dry-sucking condition, four kittens were reared together at one time and one kitten at another. Under the milk-sucking condition, three kittens were reared together at one time and two at another. The same nonlactating cat was used for each of the dry-sucking groups, while a different lactating cat was used for each of the milk-sucking groups. At no time were any signs of lactation noted in the nonlactating cat.

Since such differences in group size would have resulted in considerable disparity in the social situation characterizing the sucking sessions, an attempt was made to counteract this by including bottle-fed kittens in these sessions whenever possible. In any case, during the first 6 wk., bottle-fed littermates were normally included with the milk-sucking kittens so as to provide a better estimate of the amount of Esbilac to be stomach loaded at the feedings occurring during and after milk sucking. In no case, however, was the behavior of any bottle-fed kitten included in the results. Thus, the kittens were observed within groups varying in size from one to five. For the milk-sucking group, 39% of the total number of hours of observation occurred in groups of four, 58% in groups of three, and 3% in groups of two. For the dry-sucking group, 5% occurred in groups of five, 36% in groups of four, 17% in groups of three, 22% in groups of two, and 20% in groups of one, most of the latter occurring when the kitten was between 6 wk. and 6 mo. of age.

Recording. For each kitten, the time during which its mouth was closed over a nipple was recorded on a cumulative stopwatch for each hour of observation. For purposes of discussion this may be called a measure of sucking time, although a kitten may not have been actively sucking during the whole time that its mouth was on a nipple.

In addition, various items of behavior were observed and recorded as occurring within 30-sec. intervals scored consecutively during each hour of observation. The kittens were observed throughout the first 25 sec. of each 30-sec. interval, and the behaviors occurring in this interval were recorded then as well as in a 5-sec. break before onset of the succeeding 30-sec. interval. A kitten was recorded as exhibiting a given behavior if the behavior occurred at least once during the 25-sec. period, the one exception being that it was only scored as asleep if it appeared to be in that state throughout the 25-sec. interval. The actual number of times a given behavior was exhibited in the scoring interval was not recorded, except with respect to the number of times the kitten grasped a nipple with its mouth.

A wide variety of behaviors was observed in an

attempt to determine whether the experimental procedures had any effect on the development of other behaviors in addition to sucking. Since nuzzling in the fur of the mother cat and grasping a nipple with the mouth are both involved in the initiation of sucking (Schneirla, Rosenblatt, & Tobach, 1963), they were of particular interest. Although different behaviors were prominent at different times during development, the kittens were observed throughout the 6 mo. for the occurrence of any of the following behaviors: sucking, nuzzling, nipple grasping, playing, sleeping, full body twitching, biting other kittens, biting environment, licking self, licking others, crying, purring, kneading (rhythmic pushing of the forepaws against the mother while sucking), mouthing self, mouthing others, and empty mouthing. The occurrence of playing was recorded for a given kitten if any playful behavior was observed regardless of whether this play involved other kittens, the cat, itself, or some aspect of the environment.

Of these, however, only sucking, nuzzling, nipple grasping, playing, biting others, sleeping, and twitching proved to be important in differentiating the groups. With the exception of purring, kneading, and licking others, which did not differ between the groups, the remaining behaviors occurred too infrequently, for the most part less than 10% of the time, to warrant further consideration.

Reliability. Eighty percent of the observations were made by the first author, while 15%, 3%, and 2% were made by three different trained assistants. Since the kittens were reared in four different groups over such long periods of time, interobserver reliability was checked with each group four times during the 6-mo. period with about half of these checks occurring during the initial 6 wk. The following indexes of interobserver reliability were based on these 16 observation sessions, each of which was approximately 1 hr. in duration. The reliabilities were calculated in terms of the number of times that two independent observers agreed or disagreed with respect to whether a given behavior was observed in a given 30-sec. interval. The percentage agreement relative to the sum of the agreements plus disagreements, both summed over all 16 sessions, was 98% for sucking, 92% for nuzzling, 88% for nipple grasping, 92% for playing, 91% for biting others, 92% for sleeping, and 86% for twitching.

Data Analysis

Inasmuch as the feeding procedures, living environments, and observation schedules differed between the age periods of birth to 6 wk. and 6 wk. to 6 mo., the measures obtained in these periods were analyzed separately. All analyses involving the whole first 6 wk. were actually based on measures obtained from Day 2 through Day 42 of life, since sucking time and other behavioral measures were not available for all of the kittens until Day 2 of life. Certain behaviors which did not occur throughout this time were analyzed only over that period during which they were observed in both groups. Thus, measures of playing were analyzed only over the period from Day 18 through Day 42 of life, and measures of twitching only over the period from Day 2 through Day 32. All analyses involving the whole 20-wk. period from 6 wk. to 6 mo. were based on measures obtained in the 40 days of observation, 2 days per week, occurring from Week 7 through Week 26 of life. All of the analyses of variance reported include one independent factor, groups, and two repeated factors, days (of life) and hours (of observation). Only those F values significant at the .05 level or less are reported, and a few of these are omitted when higher order interactions are reported.

Graphic presentation of the results has been limited to those obtained in the first hour of observation on the ground that for both groups sucking and related behavior occurred most frequently during this hour. For the most part, the overall trends and general group relationships shown for the first hour are not substantially altered or reversed in any other hour of observation. Any changes that do occur over the observation hours are described in the text. Thus, the results presented in Figures 1–6 all refer to findings obtained in the first hour of observation only.

Results

Sucking

First 6 wk. During the first 3 wk. of life, the dry-sucking group sucked as much as the milk-sucking group, but in the second 3 wk., they sucked less. Measures of mean sucking time per hour obtained by the two groups over blocks of 3 days during the first 42 days of life are presented in Figure 1. Age is represented in Figure 1 as the median day of a given block of 3 days.

An analysis of variance of the sucking-time measures obtained over the whole 6 wk. indicated that the two groups showed a significant decrease in sucking time over days ($F = 6.88$, $df = 40/320$, $p < .001$). That the decrease was greater for the dry-sucking group is indicated by a significant Groups × Days interaction ($F = 1.99$, $df = 40/320$, $p < .001$). Separate analyses of variance of the sucking-time scores obtained during the first and second 3 wk. of life indicated that the two groups differed significantly only during the second 3 wk. Thus, the effect of groups was significant only in the latter period ($F = 8.60$, $df =$

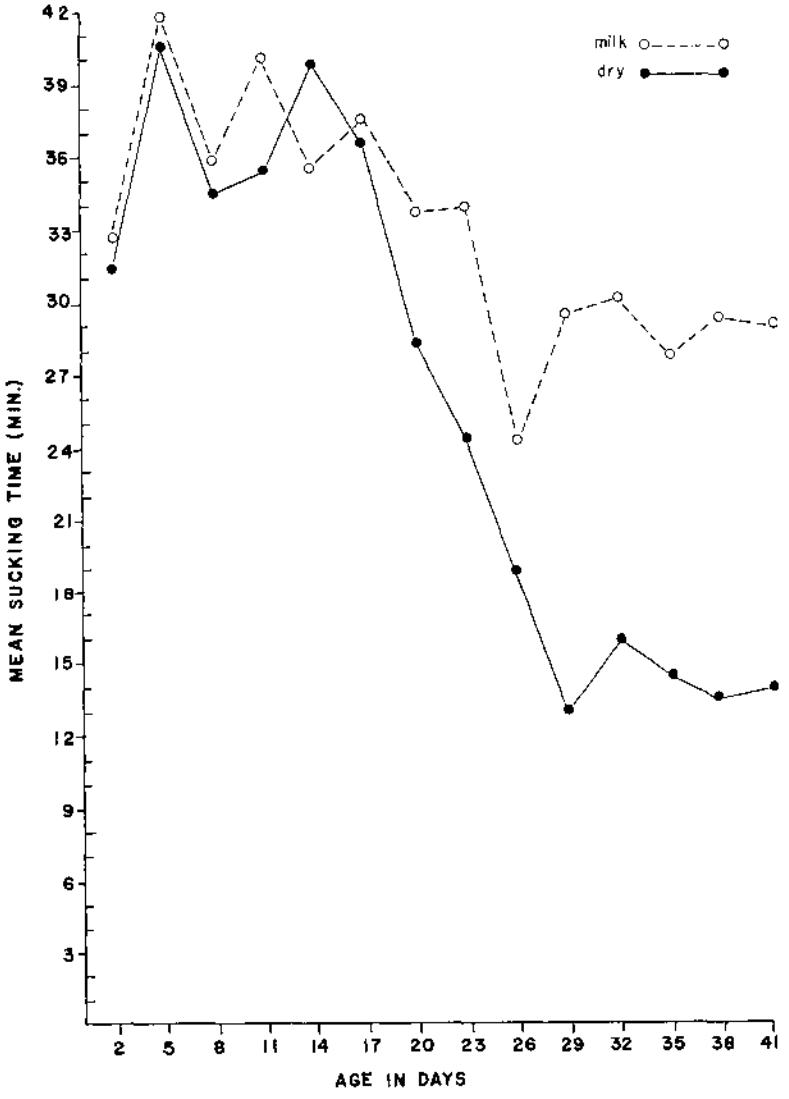

FIG. 1. Mean sucking time for milk- and dry-sucking groups over first 6 wk.

1/8, $p < .025$). None of the interactions involving groups were significant during either period.

Kittens in both groups sucked progressively less over the 3 hr. of observation ($F = 20.80$, $df = 2/16$, $p < .001$). That the decrease in sucking in the third hour, after stomach loading, was greater during the early part of the 6-wk. period is indicated by a significant Hours × Days interaction ($F = 1.54$, $df = 80/640$, $p < .005$). This trend did not differ significantly between the two groups.

The weights recorded for the two groups throughout this period of stomach loading were very similar. An analysis of variance of all the prefeeding weights recorded for the kittens over the first 6 wk. failed to reveal any significant differences between the dry-sucking and milk-sucking groups.

Six wk.–6 mo. During the first half of this 20-wk. period, the milk-sucking group sucked more than the dry-sucking group, but during the latter half, there was little difference between the groups. Measures of mean sucking time per hour per week are

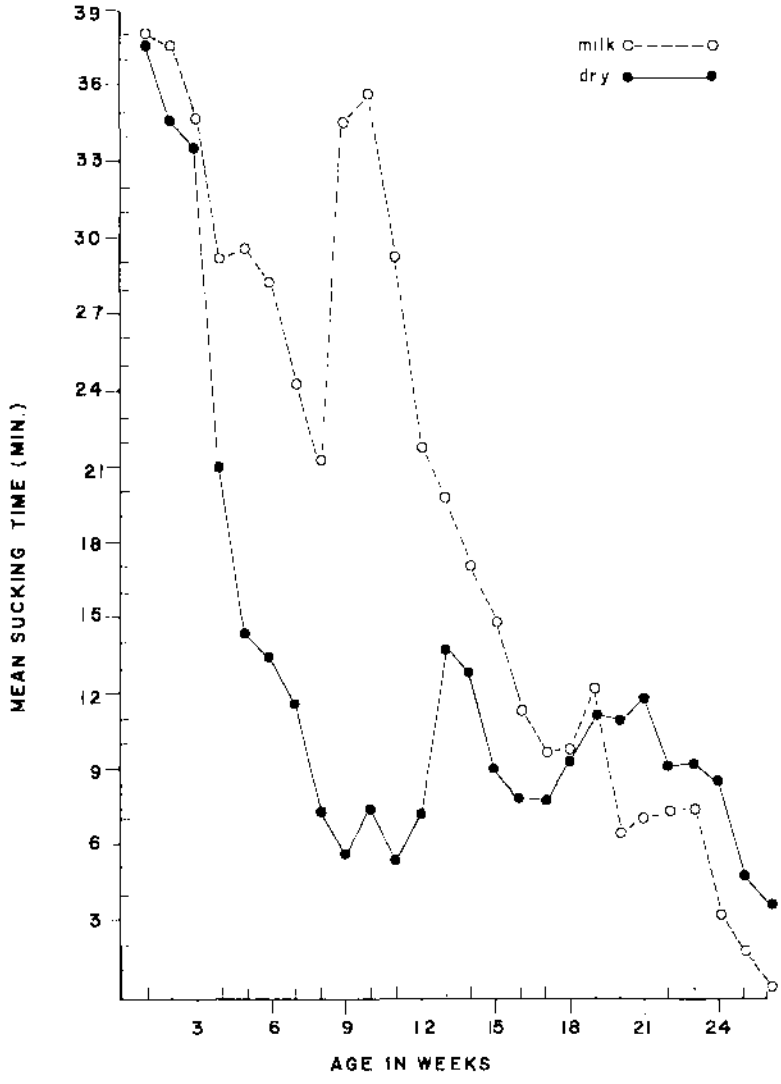

FIG. 2. Mean sucking time for milk- and dry-sucking groups over 6 mo.

plotted for the two groups over the whole 6 mo. in Figure 2. Mean values for each week, as presented in this and all subsequent figures, were computed for Weeks 7–26 from the measures obtained on the 2 days of observation each week and for Weeks 1–6 from the measures obtained on all 7 days of observation each week. Although the latter means were always analyzed separately, they were included in these figures in order to provide a comprehensive picture of behavior across the whole 6 mo.

An analysis of variance of the sucking-time measures obtained between 6 wk. and 6 mo. indicated that the difference in sucking favoring the milk-sucking group decreased over days and that this difference was somewhat greater and more persistent in the first than in the second hour of observation. Thus, the triple Groups × Days × Hours interaction was significant ($F = 1.55$, $df = 39/312$, $p < .025$). In addition, sucking time showed a significant decrease for both groups over the 20 wk. ($F = 7.84$, $df = 39/312$, $p < .001$), but not over the 2 hr. of observation.

That the difference between the groups was significant only during the first half of

the 6-wk.–6-mo. period was indicated by the results of separate analyses of variance of the sucking-time scores obtained in the first and second 10 wk. of this period. Analysis of the sucking-time measures obtained during Weeks 7–16 showed that, although the milk-sucking group sucked more than the dry-sucking group, this difference decreased over days, the trend being most striking in the first hour of observation when the milk-sucking group sucked the most. Thus, the triple Groups × Days × Hours interaction was significant ($F = 2.17$, $df = 19/152$, $p < .01$) as was the overall effect of groups ($F = 9.94$, $df = 1/8$, $p < .025$). An analysis of variance of the sucking-time measures obtained during Weeks 17–26, however, failed to reveal any significant effects involving groups. Only an overall decrease in sucking time was significant during the last 10 wk. of observation ($F = 4.84$, $df = 19/152$, $p < .001$).

A less precise measure of sucking behavior, the number of 30-sec. intervals in which sucking was observed, provided results over the 6 mo. that were very similar to those reported for sucking time and thus will not be discussed in further detail. In order to use the same scale, however, in comparing changes in sucking with changes in nuzzling, playing, and sleeping over the 6 mo., this measure, rather than mean sucking time, is used in Figures 3, 5, and 6.

Initiation of Sucking

The initiation of sucking involves a sequence of behaviors consisting mainly of nuzzling in the fur of the mother cat, which brings the mouth in contact with a nipple, and grasping the nipple with the mouth. Any tendency to initiate sucking is thus first indicated by nuzzling.

Nuzzling. Measures of nuzzling indicated that the dry-sucking group showed the same tendency to initiate sucking as the milk-sucking group and showed the same decrement in this tendency with age. In order to compare changes in the tendency to initiate sucking with changes in sucking itself, the mean number of 30-sec. intervals in which nuzzling was observed per hour per week over the 6 mo. is plotted for the two groups in Figure 3 along with a similar measure of sucking. In all figures, mean frequency refers to mean number of 30-sec. intervals.

During the first 6 wk., the two groups showed little difference in their nuzzling behavior except that the dry-sucking group nuzzled somewhat more than the milk-sucking group in the first hour of observation, this difference disappearing by the third hour. Thus, an analysis of variance of the number of 30-sec. intervals in which nuzzling occurred over all 6 wk. indicated that the only significant effect involving groups was the Groups × Hours interaction ($F = 6.08$, $df = 2/16$, $p < .025$). Both groups also showed a significant decrement in nuzzling over the 6 wk. ($F = 4.67$, $df = 40/320$, $p < .001$). In addition, they nuzzled progressively less often during the 3 hr. of observation, with the difference between the hours decreasing as they grew older, as indicated by a significant effect of hours ($F = 128.90$, $df = 2/16$, $p < .001$) and a significant Hours × Days interaction ($F = 1.31$, $df = 80/640$, $p < .05$).

During the period between 6 wk. and 6 mo., the two groups did not differ in their nuzzling behavior, although both exhibited progressively less nuzzling. An analysis of variance of the number of 30-sec. intervals in which nuzzling occurred over the 20-wk. period indicated that the only significant effect was a decrease in nuzzling over days ($F = 3.70$, $df = 39/312$, $p < .001$).

Nipple grasping. Measures of nipple grasping indicated that the dry-sucking group completed the sequence initiating sucking at least as often as the milk-sucking group and showed the same changes with age. During the first 6 wk., like nuzzling, nipple grasping was observed somewhat more often in the dry- than in the milk-sucking group. This difference was most pronounced in the first hour of observation and decreased over the 3 hr. as the amount of nipple grasping decreased so that there was very little difference between the groups during the third hour. Thus, an analysis of variance of the total number of times that nipple grasping was observed per hour over the whole 6 wk. indicated that

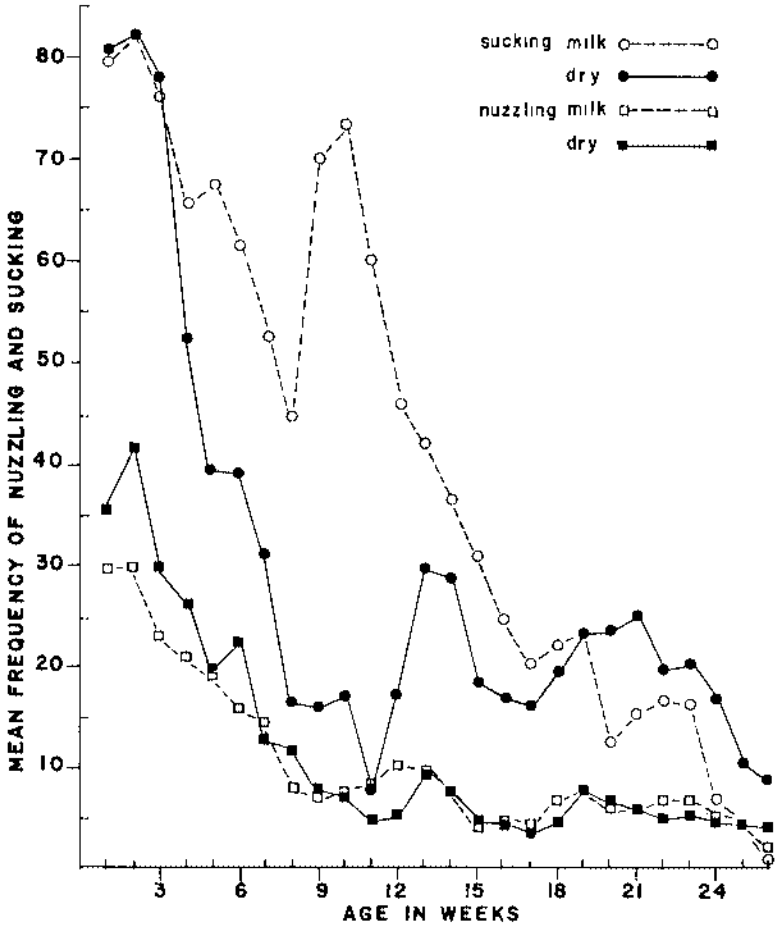

FIG. 3. Mean frequency of nuzzling and sucking for milk- and dry-sucking groups over 6 mo.

the Groups × Hours interaction was significant ($F = 26.13$, $df = 2/16$, $p < .001$), as was the overall effect of hours ($F = 79.01$, $df = 2/16$, $p < .001$). As with nuzzling, no other effects involving groups were significant. In addition, both groups showed a slight increase in nipple grasping over the 6 wk. ($F = 1.43$, $df = 40/320$, $p < .05$). During the first hour of observation, the mean number of times per hour, computed over the whole 6 wk., that the kittens were observed grasping a nipple was 23.2, with a range of 14.3–45.0 for the dry-sucking group, and for the milk-sucking group it was 9.7, with a range of 6.8–12.1.

During the 6-wk.–6-mo. period nipple grasping, like nuzzling, did not differ between the two groups. An analysis of variance of the total number of times that nipple grasping was observed over the whole 20-wk. period indicated that there were no significant effects involving groups. Both groups showed less nipple grasping as they grew older ($F = 2.60$, $df = 39/312$, $p < .001$).

Playing

In the early weeks of life, the dry-sucking group showed greater increments in playing than did the milk-sucking group, and their peak amount of playing was reached at an earlier age. The mean number of 30-sec. intervals in which playing was observed per hour per week over the 6 mo. is plotted for the two groups together in Figure 4, and separately for the dry-sucking group in Figure 5 and the milk-sucking group in Figure 6.

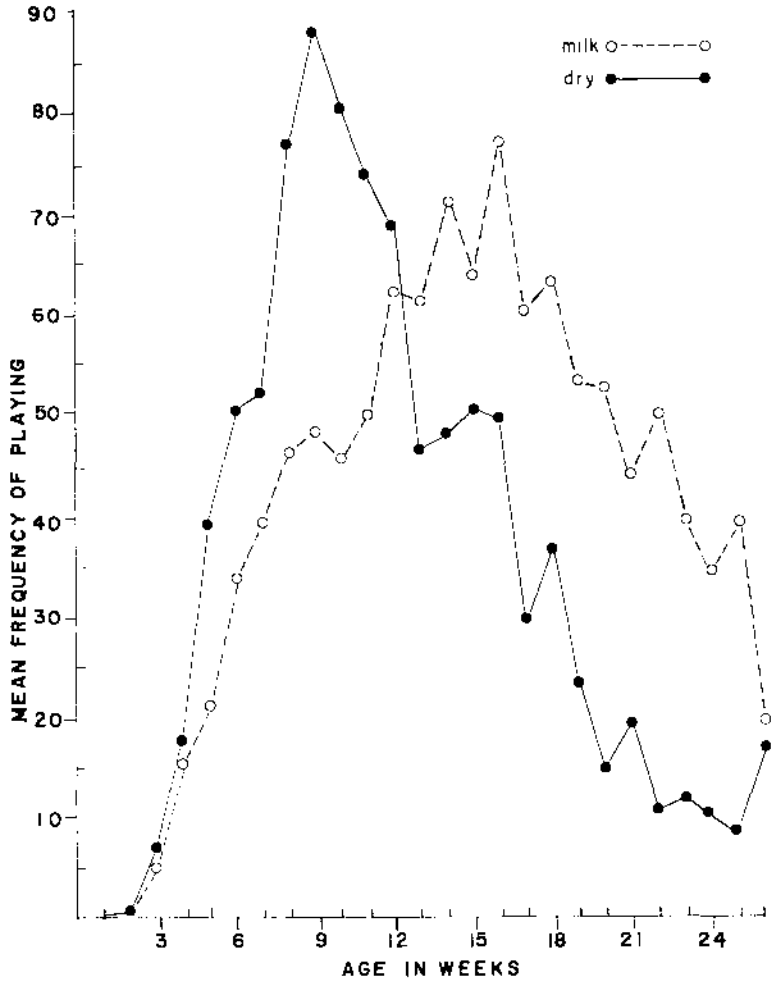

FIG. 4. Mean frequency of playing for milk- and dry-sucking groups over 6 mo.

Over the first 6 wk., the dry-sucking group played progressively more than the milk-sucking group. In an analysis of variance of the number of 30-sec. intervals in which playing was recorded, the Groups × Days interaction was significant ($F = 2.02$, $df = 24/192$, $p < .005$). This trend was similar for each hour of observation. In addition, as the growing kittens increased their play, they played most in the first hour and least in the third hour of observation, and showed increasingly greater differences in the amount exhibited each hour. Thus, the Days × Hours interaction was significant ($F = 1.58$, $df = 48/384$, $p < .025$) as were the overall effects of hours ($F = 25.97$, $df = 2/16$, $p < .001$) and days ($F = 15.62$, $df = 24/192$, $p < .001$).

The two groups did not differ in the mean day of onset of playing or of any other behavior observed. In playing, as in all other cases, the means for the two groups were so close with so much overlap in the scores that statistical analysis was not warranted.

Over the 6-wk.–6-mo. period, the dry-sucking group initially played more, but eventually played less than the milk-sucking group, as indicated by the behavior recorded in the first hour of observation. Though both groups played less during the second hour of observation, the milk-suck-

ing group played more than the dry-sucking group throughout all but the first weeks of the 20-wk. period. Both groups showed a progressive decrease in playing during the latter part of this period and a decrease in the difference between the first and second hour. Thus, an analysis of variance of the number of 30-sec. intervals in which playing occurred indicated a significant Groups × Days × Hours interaction ($F = 1.99$, $df = 39/132$, $p < .001$). In addition, the overall effects of days ($F = 8.99$, $df = 39/132$, $p < .001$), hours ($F = 19.21$, $df = 1/8$, $p < .005$), and groups ($F = 6.02$, $df = 1/8$, $p < .05$) were significant.

The dry-sucking kittens reached their peak amounts of playing at an earlier age than the milk-sucking kittens, as indicated by the behavior recorded in the first hour of observation when the greatest amount of playing occurred. When the 2 wk. in which the kittens were observed to play most frequently were averaged to obtain a mean peak week of playing for each kitten, the kittens in the dry-sucking group were all found to peak at an earlier time than those in the milk-sucking group. The median of the mean peak weeks obtained for the dry-sucking kittens was 9.5 wk., with a range of 8.5–11.5. The median for the milk-sucking kittens was 15, with a range of 12–17. This difference is significant at the .008 level by a two-tailed Mann-Whitney U test. Even though the dry-sucking kittens showed peak

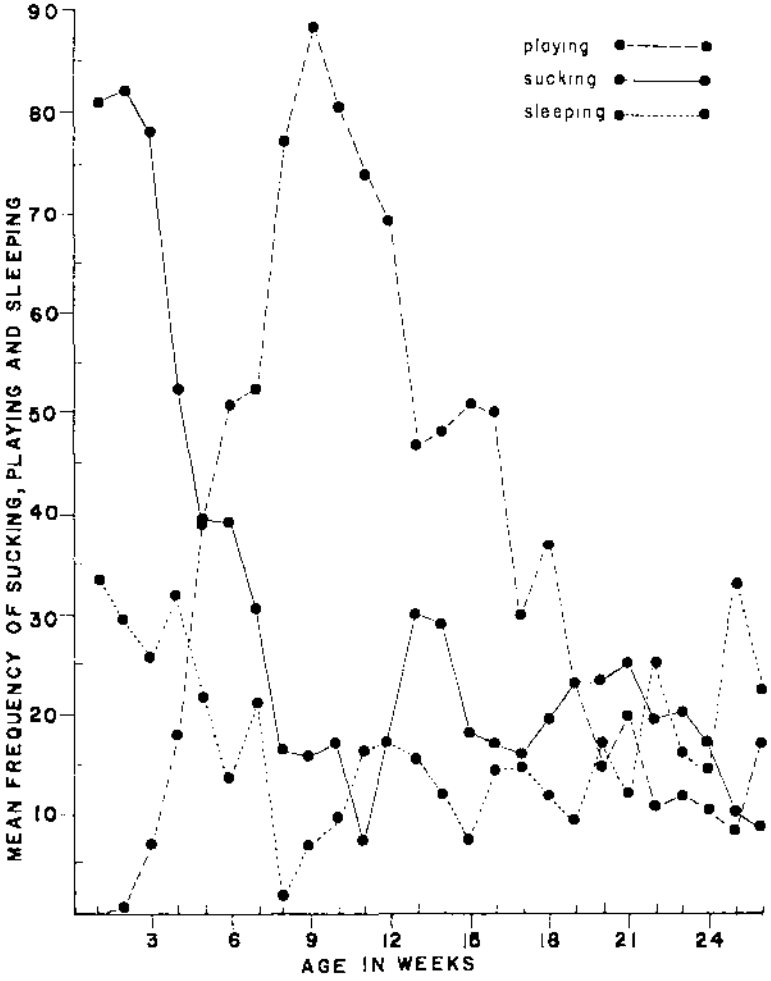

FIG. 5. Mean frequency of sucking, playing, and sleeping for the dry-sucking group over 6 mo.

amounts of playing earlier than the milk-sucking kittens, the actual amounts observed at these peak periods did not differ significantly between the groups as indicated by the same test.

The occurrence of another behavior which very often accompanied playing, biting others, was distributed over the 6-mo. period for the two groups in very much the same manner as playing.

Sleeping

Over the 6 mo., the two groups exhibited first a decrement and then an increment in ½-min. sleeping episodes with the dry-sucking group sleeping more than the milk-sucking group in the 6-wk.–6-mo. period. In order to compare changes in sleeping, sucking, and playing, the mean number of 30-sec. intervals per hour per week in which sleeping was recorded over the 6 mo. is plotted separately for the dry-sucking group in Figure 5 and for the milk-sucking group in Figure 6.

During the first 6 wk., the two groups did not differ significantly in the number of ½-min. sleeping episodes exhibited. Both groups, however, showed a decrease in sleep over the 42 days and both showed an increase over the 3 hr. of observation, the increase being greater earlier in the 6-wk. period. Thus, an analysis of variance of the number of 30-sec. intervals in which sleeping was recorded over the whole 6 wk. indicated that the effects of days ($F = 5.82$, $df = 40/320$, $p < .001$) and hours ($F =$

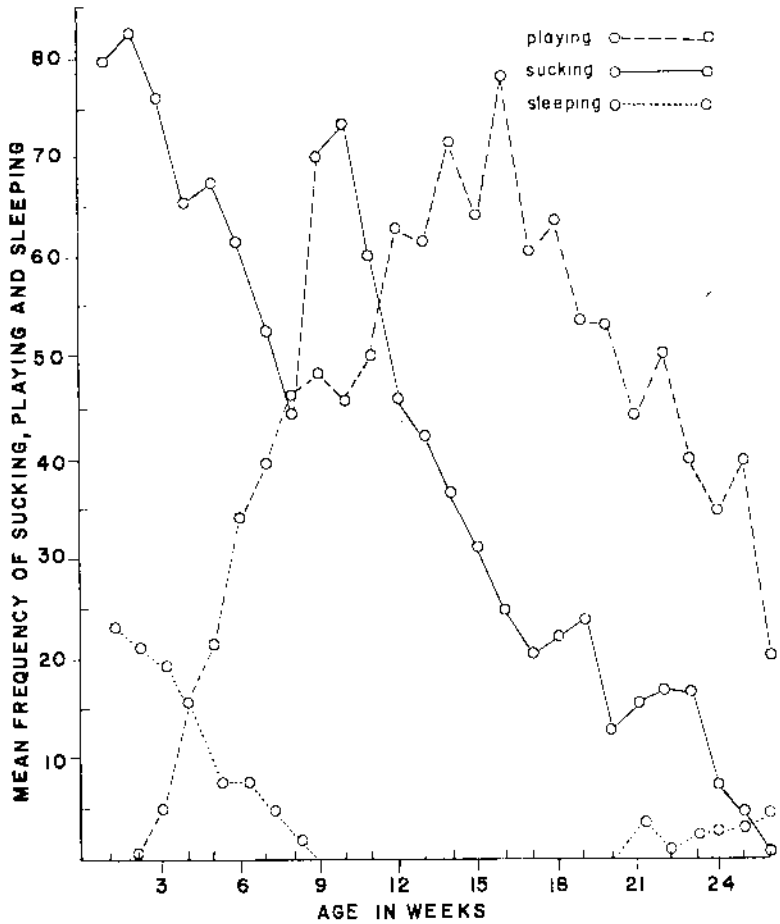

FIG. 6. Mean frequency of sucking, playing, and sleeping for the milk-sucking group over 6 mo.

214.83, $df = 2/16$, $p < .001$) were significant as was the Days × Hours interaction ($F = 1.30$, $df = 80/640$, $p < .05$). There were no significant effects involving groups.

During the 20-wk. period between 6 wk. and 6 mo., the dry-sucking group slept more often than did the milk-sucking group, which slept very little during the observation sessions. This difference, based on summing over the whole 20 wk. to obtain the mean number of 30-sec. intervals of sleep per hour evidenced by each kitten, was significant at the .008 level for each hour of observation by two-tailed Mann-Whitney U tests. In each hour, all kittens in the dry-sucking group slept more than those in the milk-sucking group. In addition, all of the kittens in both groups slept more in the second than in the first hour of observation. Using the means just described, a two-tailed sign test of the increase in sleep from the first to the second hour was significant at the .002 level for all of the subjects considered together. Both groups also evidenced an increase in sleeping over the 20-wk. period. During the first hour, 8 of the 10 kittens showed an increase in the mean number of intervals of sleep per hour from the first to the second 10 wk. of this period. A two-tailed sign test of this increment, however, yielded a p value of only .110. During the second hour, 7 of the 10 kittens showed a similar increase.

Twitching. Since gross body twitching usually occurs when a kitten is asleep, the following results suggest that early in life there may have been slight differences between the groups that were not observed with the present measure of sleeping. Whether these might have involved differences in the duration of sleeping episodes, occurrence of various sleep states (Valatx, Jouvet, & Jouvet, 1964), or some other aspect of sleep cannot be resolved with the present data. In any case, the differences were slight and limited to roughly the first 4 wk.

During the period from approximately the second through the fourth week, the milk-sucking group evidenced gross body twitching slightly more often than did the dry-sucking group, although the reverse was true during the first week. In an analysis of variance of the number of 30-sec. intervals in which twitching was observed, the Groups × Days interaction was significant ($F = 1.85$, $df = 30/240$, $p < .005$). Very little twitching occurred after the first 4½ wk., but within that time the two groups showed a significant decrease in twitching ($F = 23.76$, $df = 30/240$, $p < .001$). As with sleeping, both groups showed progressively more twitching from the first to the third hour of observation, but the differences in the frequency of twitching exhibited each hour decreased as the total amount of twitching decreased over days. Thus, the Hours × Days interaction was significant ($F = 3.55$, $df = 60/480$, $p < .001$), as was the overall effect of hours ($F = 107.70$, $df = 2/16$, $p < .001$).

Discussion

Sucking

The fact that the dry-sucking group sucked as much as the milk-sucking group during the first 3 wk. of life and continued to suck to some extent throughout the 6 mo. cannot be explained on the basis of the acquired drive hypothesis. Since the dry-sucking group never experienced milk in direct conjunction with sucking, an oral drive could not have been acquired on the basis of food reward.

On the other hand, since both groups were given an equal opportunity to suck in a relatively normal sucking situation, the higher level of sucking by the milk-sucking group during part of the 6-mo. period cannot easily be explained on the basis of a strictly formulated unlearned drive hypothesis. If all sucking is merely the expression of a primary oral drive, then both groups would be expected to exhibit the same amount of sucking throughout the 6-mo. period. Thus, these results suggest that neither the acquired nor the unlearned drive hypothesis provides an adequate explanation of sucking.

When sucking behavior is analyzed in terms of its initiation and prolongation, it appears that the effect of milk is mainly on the prolongation rather than the initiation

of sucking in the normal situation. At no time during the 6 mo. did the dry-sucking group initiate sucking less frequently than the milk-sucking group, as indicated by the results obtained with nuzzling, shown in Figure 3, and nipple grasping. Thus, the greater decrease in sucking time by the dry-sucking group must have been caused largely by a decrease in the length of sucking episodes. This strongly suggests that in the normal situation, milk operates to prolong sucking when it occurs but has little effect on the tendency to initiate sucking. Early in life, however, milk does not even appear to have this effect, since the duration of sucking did not differ between the two groups during the first 3 wk., as illustrated in Figure 1. Although practice in initiating sucking may well be important in maintaining initiation beyond the initial week of life, as proposed by Kovach and Kling (1967), these results suggest that reinforcement with liquid intake is not necessary for the maintenance of initiation in the normal situation. Thus, in the normal situation, the initiation, and to some extent the prolongation, of sucking is determined by variables other than those specifically associated with milk or food reward.

The apparent decrement in the effect of milk with age, suggested by the eventual reduction in sucking shown by the milk-sucking group in Figure 2, may have been in large part due to a decrement in the amount of milk produced by the mother cats. The two cats used in this study were found to have stopped lactating completely by Weeks 20 and 21, although prior to this time milk production had no doubt undergone a progressive change in quantity and quality. Active avoidance of the kittens by these cats was not an important factor in this sucking decrement as they were fairly docile with the kittens, perhaps because they were only confined with them 2 hr. a day.

During the last weeks of the 6 mo. when milk was no longer available for the milk-sucking group, they showed a decrement in sucking to close to the zero level. Since the dry-sucking group showed a similar trend at about the same age, these results suggest that the prior association of milk with sucking had little effect on the timing of this final decline in sucking.

The decrement with age in the tendency to initiate sucking, as shown in Figure 3 for nuzzling, does not appear to vary as a function of changes in the mother cat. Both groups showed a similar decrement in the initiation of sucking over the 6 mo., as indicated by the results obtained with nuzzling and nipple grasping. Although the physiology and social responsiveness of the lactating cats may have changed in relation to the age of the milk-sucking kittens, it is highly unlikely that such systematic changes with age would have occurred in the cat which was not lactating and which, for the most part, did not even experience the dry-sucking kittens. Granting that ordinarily a mother cat may make herself first highly, and later less, available for the initiation of sucking by kittens, as reported by Rosenblatt, Turkewitz, and Schneirla (1962), the results of the present research, in which changes in availability were minimized, suggest that nevertheless there are age changes in the initiation of sucking which are not necessarily due to changes in the mother cat.

Playing

The results plotted in Figure 4 show that the development of playing was accelerated for the dry-sucking group such that they reached a peak of playing earlier than the milk-sucking group. Although they did not exhibit their first playful behaviors any earlier, the dry-sucking group showed an increasingly greater frequency of playing almost from the moment that playing was available. That this represents an acceleration in the development of playing rather than simply a greater amount of playing is suggested by the finding that the peak amount of playing did not differ significantly between the two groups and that after reaching this amount both groups showed a similar decrement in playing. Furthermore, the finding that the two groups showed a decline in playing after reaching similar maximum frequencies rather than similar ages suggests that the

eventual decrement in playing may be related more to reaching a certain level of occurrence than a certain age. The general finding of first an increment and then a decrement in playing with age has also been reported by Mason (1967) for chimpanzees.

The fact that playing was accelerated for the dry-sucking kittens early in the 6 mo. suggests that the development of playing may be related to sucking. For both groups the peak of playing occurred at a time when sucking had reached a fairly low level of occurrence, as indicated in Figures 5 and 6. For the dry-sucking kittens this may have occurred earlier partly because their sucking decreased to a low level earlier. For the milk-sucking kittens the peak may have occurred later partly because their sucking decreased later due to the effect of milk in prolonging sucking. If so, this suggests that the rate of development of a later appearing behavior, such as playing, may be related to the frequency of occurrence of an earlier behavior, such as sucking. A notion somewhat similar to this has been advanced for human infants in regard to reciprocal relations in the development of certain verbal behaviors (Wahler, 1969).

Sleeping. Over the 6 mo., both groups exhibited a decrement and then an increment in sleeping at about the same time that they showed the opposite trend in playing, as illustrated in Figures 5 and 6. With the initial decrement in sleeping, the kittens were awake more and thus more available for playing. As they grew older, however, they played less and started to sleep more. Both groups appear to have exhibited this increment in sleep at around the time they reached or passed the peak of playing, suggesting a possible relation between the decline of playing and the increase of sleeping. Further evaluation of this relation would depend, however, upon the extent to which these later increments in sleeping represent a developmental trend and would require observations extending beyond the 6 mo. of the present study. That the milk-sucking kittens generally slept less than the dry-sucking kittens over the 6-wk.–6-mo. period suggests that, though they seldom played with the mother cat, they may have been somewhat activated by her presence as they grew older.

Effects of Observation Time and Food Intake

The changes in behavior reported over the hours of observation suggest that putting the kittens in the observation situation had a general activating effect which decreased with the passage of time in the situation. In the first 6 wk. the frequency of occurrence of all the active behaviors reported was highest in the first and lowest in the last hour of observation, while for sleeping the reverse was true. Although in the period between 6 wk. and 6 mo. this decrement in activity over hours was found only for the more frequent behaviors, such as playing, sleeping did increase over the 2 hr. of observation.

Such results might have been expected for the milk-sucking group on the grounds that ingestion of milk would make this group sleepy and therefore less active. On the other hand, this same sort of reasoning would have led to the expectation that the dry-sucking group, which received no milk for sucking, would become more active and relatively less sleepy as the hours progressed. The results indicate, however, that this did not happen as, in general, the two groups showed similar changes in behavior over the hours of observation and in no case did the dry-sucking group show greater activity in the second than in the first hour of observation.

Food intake did appear to have some effect on the kittens because, in the first few weeks, both groups showed a marked decrease in sucking in the third hour of observation after stomach loading, a finding in line with that reported by Stanley and Bacon (1963) for puppies. As the kittens grew older and sucked less, the size of this decrement decreased so that by around 4 wk. it could not be separated from the general decrement in activity over hours. Although the effects of stomach loading and time in the observation situation cannot be wholly separated, these results suggest that the effect of stomach loading on sucking may vary with age.

Mother–Infant Relations in Sucking and Socialization

The present results suggest that an active mother cat is not necessary for the initiation and maintenance of sucking as long as kittens are put in close proximity to a mother figure. They further suggest that an active mother is not necessary for the development of social relations as long as kittens regularly have an opportunity for interaction. Without the aid of an active mother, the kittens in the dry-sucking group sucked and developed apparently normal social relations as evidenced by play and other behaviors. They were not found to cry any more or purr any less than the milk-sucking kittens. In addition, they apparently developed normal sexual behavior, since one of the female kittens from the dry-sucking group had kittens of her own when she was caged with a male kitten from the milk-sucking group at the end of the study. Findings similar to these have also been reported by Harlow and Harlow (1969) for monkeys. Thus, it appears that although the activities of the mother cat may be important, they are not necessary for sucking and socialization.

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