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14. See D. Moody, W. Stebbins, and J. Miller [*Behav. Res. Methods Instrum.* **2**, 180 (1970)] and D. Moody, M. Beecher, and W. Stebbins [in *Handbook of Auditory and Vestibular Research Methods*, C. Smith and J. Vernon, Eds. (Thomas, Springfield, Ill., 1975), p. 439] for details of instrumentation and behavioral procedures.
15. Two problems encountered by nearly all human auditory laterality research are (i) subjects perform nearly perfectly, producing few errors with either ear; and (ii) partially as a function of (i), the performance differences between the two ears are very small. These problems are especially evident when a monaural stimulus presentation mode (*3*) is used. In fact, the dichotic listening paradigm is generally the method of choice because it results in more errors and somewhat larger ear performance differences than the monaural preparation (*4–6*). The laterality data summarized here, however, were collected in the course of a series of studies whose prime objective was not to study laterality, but rather to determine whether certain other phenomena characteristic of human speech perception might also be manifested by nonhuman primates listening to conspecific sounds. For several reasons, the dichotic listening task was simply not suited to answering these questions. Thus, the monaural listening task was selected as a compromise technique because it would simultaneously yield the information sought from the primary experiments and provide some valuable insights into the laterality question.
16. Each animal was required to satisfy three conditions in each of two successive sessions in order to advance from one stage to the next. The animal needed to (i) respond correctly to 90 percent of the total SE's delivered to the "superior" ear for that day; (ii) respond correctly to at least 80 percent of the presentations to the superior ear of each different SE exemplar; and (iii) respond to no more than 10 percent of any individual SL exemplar presented to the superior ear. The superior ear was that ear which, on a given day, was most accurate in identifying SE's.
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Effects of the Home Environment on Withholding Behaviors and Conditioning in Infant and Neonatal Rats

Abstract. *Rats 16 days old received passive-avoidance training in the presence or absence of home litter cues. Rats trained in the context of home litter cues learned the passive avoidance reliably faster than rats trained in isolation. In the presence of home litter cues, 16-day-old rats also exhibited more adultlike spontaneous alternation. Pavlovian conditioning of rats trained at 2 days of age was studied in the presence and absence of conspecifics. These experiments suggest that deficiencies in inhibitory behaviors and conditioning associated with immaturity can be alleviated when the testing environment is made more similar to the home environment.*

Logically, it seems adaptive for an organism to first develop the ability to learn and retain those events associated with feeding (for example, imprinting) (*1*). One example is that 7-day-old rat pups seem to learn a position discrimination and retain it for several days if reinforced by contact with the mother and suckling a dry nipple (*2*). In contrast, pups of the same age have difficulty learning a simpler problem to escape shock, with retention for this memory lasting no more than a few hours (*3*). Other evidence, however, suggests that the critical requirement for the manifestation of early learning and retention in the laboratory is not that the circumstances be more appetitive than aversive, but only that the task generally be structured to the animal's capabilities (*4*, *5*).

A study of the testing procedures with immature rats suggested to us that a critical determinant of the manifestation of learning and retention in these animals might be the presence of familiar home environmental cues during conditioning and testing. To test this hypothesis we first chose a learning task in which infant rats are inferior to older rats (passive avoidance) (*6*, *7*) and examined their performance in the presence of home litter cues (*8–10*). The subjects were 60 albino Sprague-Dawley rats born and raised in the colony of the State University of New York at Binghamton (*11*). Ten rats per group (five males, five females) were randomly assigned to six groups arranged in a factorial combination of age (16 days versus 80-day-old adults) by treatment [trained with no shavings (group NS), trained with clean wood shavings (group CS), and trained with home litter shavings (group LS)].

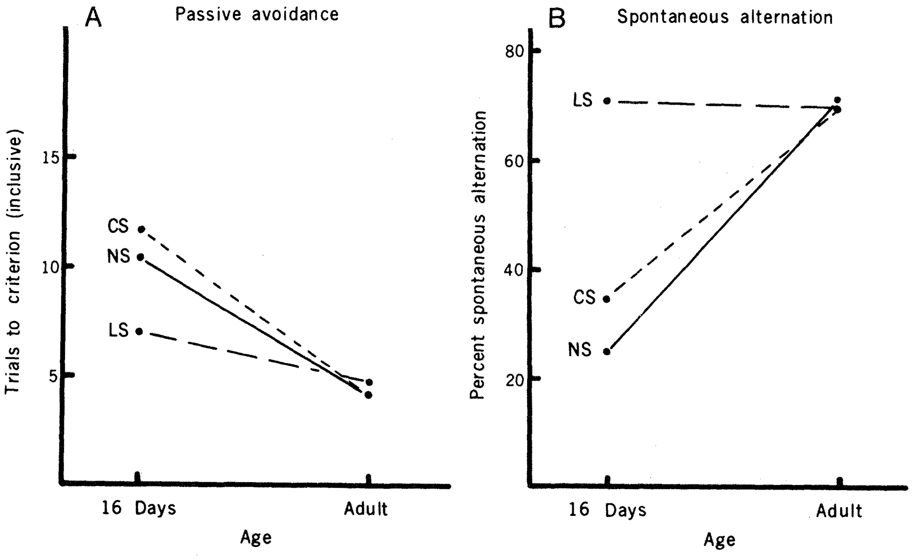

Fig. 1. Influence of litter shavings (*LS*), clean shavings (*CS*), or no shavings (*NS*) on passive-avoidance behavior (A) and spontaneous-alternation behavior (B).

Rat pups were trained to inhibit crossing into the black (shocked) compartment of a two-chamber, black and white apparatus. Two apparatuses were used, one for adults and an identical smaller one scaled to the size of the 16-day-old rat pup (*6*). A Plexiglas tray located immediately beneath the grid floor in each compartment held wood shavings for groups LS and CS. At the start of training, each rat was placed into the white compartment; when the rat placed four paws inside the black compartment a 0.5-mA, 0.5-second shock was delivered through the grid floor. Immediately thereafter the rat was taken out of the black compartment and placed in a holding cage for 30 seconds to await the next trial. Training continued until each rat withheld crossing into the black compartment for 60 seconds on two consecutive trials. The datum of interest is the mean number of trials to criterion.

The presence of home litter shavings beneath the shock grids facilitated acquisition of the passive avoidance in 16-day-old rat pups without influencing learning in the adult (Fig. 1A). Furthermore, none of the other treatments had any influence on learning the passive avoidance at either age. An analysis of variance confirmed these interpretations by indicating a reliable age-by-treatment interaction ($P < .025$) and a main effect of age ($P < .001$). In addition, at 16 days of age, group LS required reliably fewer trials to learn than age-mates in groups NS and CS ($P < .05$), but did not differ from adults in group LS ($F < 1$). Furthermore, adults in groups NS and CS learned the passive shock-avoidance reliably faster than 16-day-old pups in groups NS and CS ($P < .01$).

These results (i) confirm our initial hypothesis that early learning and retention may be facilitated when training occurs in the context of home environmental cues; (ii) support other experiments suggesting that under certain conditions, inhibitory functioning may be manifested much sooner than previously reported (*12*); (iii) offer further support for the hypothesis that the infant rat provides a workable animal model for the study of hyperkinesis (*13*); and (iv) support the contention that environmental manipulations may be a useful substitute for drug treatment in dealing with hyperkinesis and concomitant learning difficulties (*14*).

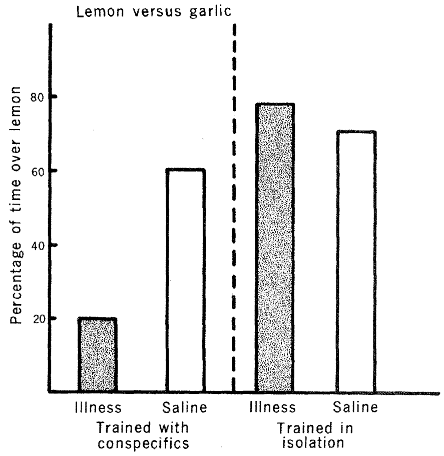

Fig. 2. Effects of isolating 2-day-old rat pups during Pavlovian conditioning.

Since environmental manipulations can also decrease locomotor activity in infant rats (*9, 10, 15*), we designed experiment 2 to answer the question, Were the infants trained in the presence of the home litter shavings actually learning something about the environment or were they merely showing a decrease in locomotor activity that happened to be manifested as passive-avoidance behavior? We examined another response measure that has been studied ontogenetically as an index of response inhibition, spontaneous alternation. Immature rats have been reported to show less spontaneous alternation in a T maze than adults (*16*). If the results of experiment 1 resulted merely from a general decrease in locomotor activity, spontaneous alternation behavior should not change during exposure to home environmental cues. On the other hand, if the presence of the home environmental cues enables the rat to learn more about the immediate environment, the rats should respond more like adults.

The subjects were 84 albino rats, like those studied in experiment 1, divided into six groups of seven males and seven females per group. Rats were then assigned at two ages (16 days and adults) in a factorial arrangement of the three treatments from experiment 1 (*11*).

A T maze (*17*) mounted on a grid floor had a Plexiglas tray for holding wood shavings beneath the grid floor. Testing consisted of three trials separated by intertrial intervals of 30 seconds. At the beginning of testing each rat was placed in the start box of the maze; after 3 seconds, a door was lifted and a latency timer started. If the rat failed to choose within 90 seconds, the trial was terminated. The datum was the probability of alternation between arms of the maze on successive trials.

The presence of home litter shavings beneath the T maze increased the percentage of alternating responses in the 16-day-old rat pup relative to age-mates given either no shavings or clean shavings (Fig. 1B). For adults, no differences were observed between treatment groups. Analysis of variance indicated a reliable age-by-treatment interaction ($P < .01$) and main effects of age ($P < .001$) and treatment ($P < .025$). The presence of home litter shavings reliably increased the probability of an alternating response in 16-day-old rats in group LS relative to age-mates in groups CS or NS ($P < .05$). Similarly, the adults in groups CS and NS performed significantly more alternating responses than 16-day-olds in groups CS or NS ($P < .05$). There were no differences between 16-day-olds and adults in group LS ($F < 1$).

The results of groups NS and CS (16-day-olds) agree with previous reports that immature rats exhibit relatively less spontaneous alternation than adults (*16*). Furthermore, the performance of the adults agree with other reports (*18*). The most interesting finding is the increase in alternation behavior when pups are tested in the presence of home litter shavings, which indicates that the results of experiment 1 are due to modulation of an active inhibitory process rather than merely an influence on general locomotor activity. In addition, these results suggest that young rats trained in the presence of home environmental cues may be able to learn more about their immediate environment than isolated animals. In the cases of passive avoidance and spontaneous alternation, the tendency for young animals to perseverate has typically been attributed to an underdeveloped inhibitory system. In particular, reviews have suggested that the inhibitory deficits seen in young animals may be due to an immature hippocampus, which is thought to modulate inhibitory behaviors (*19*). More recently, though, the notion that the hippocampus modulates inhibitory responding has been questioned (*20*); the deficit following hippocampal damage may result from the organism's using different and less effective cues and learning strategies than normal subjects. Perhaps the presence of home environmental cues enables the animal to use more of the cues or learning strategies used by adults in learning the response. If so, the presence or absence of home environmental cues may influence the rate of learning and perhaps also retention.

To test whether the effects reported were more broadly related to the processing of memories, we followed a procedure first developed by Rudy and Cheatle (*4*) in which an odor (lemon) is paired with LiCl illness at 2 days of age and the test for conditioning is given several days later. This procedure offers a unique test of our original hypothesis that learning and retention may be improved in the context of home environmental cues, since in each of many experiments, Rudy and Cheatle have simultaneously exposed all rats from a litter to the odor. Hence, all rats were experiencing the onset of illness not only in the presence of the paired odor, but also in the presence of an important home environmental cue, conspecifics. Experiment 3 compared the effects of conditioning pups in isolation and with conspecifics.

Albino rats ($N = 36$) were trained 2 days and tested 9 days after birth. Each pup was randomly assigned to one of four treatment groups (nine per group) arranged in a 2 by 2 factorial design [presence of conspecifics during training versus trained in isolation by illness (injection of 2 percent of body weight of a $0.15M$ solution of LiCl) versus no illness (saline)].

The conditioning procedure was the same as that of Rudy and Cheatle (*4*) except that each pup trained in isolation was exposed to the experimental treatments alone, in isolation from littermates. Otherwise the groups were identically treated. Each pup was tested individually over a 5-minute period for its preference between lemon or garlic odors (*21*) to determine the percentage of time spent over the lemon odor.

Pups given the lemon odor-illness pairing in the presence of conspecifics spent less time over the lemon odor than control pups given the lemon odor with saline (Fig. 2). This replicates the Rudy-Cheatle finding that 2-day-old pups can learn an association of odor with illness and retain it over a surprisingly long interval. However, of primary interest is the influence of isolating the pup during learning (Fig. 2). Pups given the odor-illness pairings in isolation spent as much time over the lemon odor as the controls did. Apparently, training the pup in isolation from littermates markedly disrupted learning or the subsequent retention of Pavlovian conditioning. Analysis of variance indicated a reliable interaction ($P < .05$) and main effect of training environment ($P < .01$). Although pups given the odor-illness pairing in isolation did not differ from their saline controls or saline controls experiencing the odor with conspecifics ($F < 1$), all these groups did differ reliably from the group given the odor-illness pairings in the presence of conspecifics ($P < .01$).

These experiments suggest that separation of the rat pup from familiar home environmental cues disrupts learning or retention. The early learning and retention reported by Kenny and Blass (*2*) may not necessarily reflect a general disposition of the organism to learn an appetitive response sooner than a shock-motivated response, but rather the importance of learning about the response contingencies in the presence of home environmental cues (in their case, the anesthetized adult female).

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Astigmatism in Infants

Abstract. *Compared with children of school age, infants show ten times the incidence and considerably greater amounts of clinically significant astigmatism. The amount begins to decrease in the second semester of life, and the incidence declines during the third year. These unanticipated results bear on both the etiology and the neural sequelae of astigmatism.*

In the course of refracting the eyes of 276 full-term infants between birth and 50 weeks of age by means of near-retinoscopy (*1*), we discovered that clinically significant astigmatism (*2, 3*) occurred in 45 percent of the sample (*4, 5*). This incidence is almost ten times that reported in children (*6*) and five times that reported in adults (*7*), which implies that much of the early astigmatism must be either reduced or eliminated in the course of development.

The unexpectedly high incidence is interesting in light of the inference that astigmatism has deleterious effects upon the development of the visual nervous system. The meridional amblyopia found in adult astigmats represents an optically uncorrectable loss of acuity, attributed to irreversible changes in the visual nervous system (*8*). These changes are, in turn, attributed to prolonged exposure to the blurred edges of images of contours of all orientations except the focused meridians. Furthermore, these central abnormalities in human observers have been said to parallel the changes in the incidence of orientationally selective neurons in the visual cortices of cats reared either with edges of only one orientation visible (*9*) or with strong astigmatic lenses (*10*). Finally, one wonders how the high incidence of astigmatism during human infancy bears on the timing of a sensitive period during which astigmatism may cause irreversible deficits in vision.

In this report we report the results of the initial refractions of the right eyes of 276 infants (*11*). In addition, we tracked the refractions of 28 of these infants who had shown 2 or more diopters of astigmatism at some time between 3 and 6 months of age. All of the infants were healthy and full term with birth weights ranging from 2381 to 4904 g for 141 males (median = 3487 g), and from 2410 to 5075 g for 135 females (median = 3289 g). The majority of the infants were solicited through letters mentioning tests of