Exposure learning of auditory stimuli by rats

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Albino rats were raised in the presence of a tone and later tested for preference for that tone or a novel tone. Two experimental groups were exposed to either a solid (S) or a pulsing (P) tone continuously from birth and later were compared to a control (C) group raised in the absence of tone. Group differences in preference for solid or beeping tone emerged only after a 2-week silent period, with significantly greater preference for the pulsing tone exhibited by Group P over Group C and by Group C over Group S. No difference was obtained between Groups C and P. Explanation of this latter finding involved confounding effects of a natural preference for the intermittent tone.

Many theorists (Hess, 1968; Sluckin, 1965) have suggested that sensory input for young developing animals may subsequently influence the development of preference behavior for a particular sensory input. Labeled "exposure learning" by Sluckin and "environmental imprinting" by Hess, this hypothesized phenomenon has received some empirical support. The typical design involves exposing young animals to stimuli, usually auditory or visual, and later testing these animals to determine preference for the early experience stimulus vs some alternate stimulus. Grier, Counter, & Shearer (1967) found that chicks exposed to a beeping sound during incubation would, after hatching, prefer that sound to a novel beeping sound. Hess (1959) exposed young chicks to patterned environments at around 2 days of age and found an imprinting effect, in that they later preferred the patterned environments. He also reports anecdotally on the effects of a more global early environmental experience involving nesting preferences of adult mallard ducks who preferred nest sites similar to those in which they had been reared. Sluckin & Fullerton (1969) "exposure-trained" infant guinea pigs with either a rotating striped cube or a tennis ball and found that the animals spent more time near the object with which they had been trained. A provocative study (Cross, Halcomb, & Matter, 1967) exposed young rats to musical selections by either Mozart or Schoenberg. In test situations, the Mozart Ss preferred Mozart, although no preference was found among the Schoenberg or control Ss. Explanations offered for this phenomenon focused on stimulus complexity as a possible confounding variable, since the stimuli used were complex and unquantifiable.

The present study was designed as a replication of Cross, Halcomb, and Matter's investigation, except that the

auditory stimuli were simplified and longer exposure and testing periods were employed.

SUBJECTS

The Ss were 18 Holtzman albino rats, nine male and nine female. Since the experiment began at birth, litters were later adjusted to equate groups by sex through a process of random elimination.

APPARATUS

The chambers in which the animals were raised and tested were three aluminum-lined plywood boxes ($17\frac{1}{2} \times 17\frac{1}{2} \times 12$ in.). Audio stimulation consisted of a 1,000-Hz tone presented through speakers mounted above the lid of the boxes.

Food and water were provided in two of the chambers (rearing boxes) by a feeder and water bottle attached to the outside of the box, and an opening was provided for ventilation. The third chamber (testing box) was identical to the rearing chambers except for a hinged floor and access to water only. Relay apparatus made possible the programming of sound contingent upon the Ss' depressing one or the other side of the hinged floor. Clocks and timers were used for timing and recording session length and preference.

PROCEDURE

Three groups of six rats each were reared successively in the rearing chambers to constitute the one control and two experimental groups. To insure that the newborn Ss' earliest experience would be with the exposure tone, pregnant female rats were placed in each rearing chamber either prior to or within 12 h of parturition. At 21 days of age, the mother rat was removed and the pups were separated by sex between the two chambers. The exposure stimulus for one group, Group S, was a solid tone of a sound pressure level of 67 dB, as measured by a B & K sound level meter with a 1,000-Hz 1-octave filter. The second experimental group, Group P, experienced a tone pulsing at

a rate of 5 pulses/sec, with the same pitch and intensity. The control group, Group C, was reared in the exposure boxes with the sound disconnected. For the experimental animals (Groups S and P), the sound was continuously presented for 24 h a day until Ss were 45-50 days of age.

After the early experience condition, Ss were given two testing periods. At 45 days of age, each S was placed in the test chamber for individual sessions. The initial two sessions for each S were 3 h each in length in order to adapt the animal to the box and therefore increase their tendency to move about the box and experience both tones. (Pilot work indicated that Ss would freeze upon first being placed in the test chamber, thereby depressing only one side of the floor for a long period of time.)

In remaining sessions, Ss were run for 2-h sessions, three Ss per day; consequently, it took 2 days to expose all Ss to one session. After each session, each S was returned to the exposure chamber where the exposure stimulus was maintained. In the test chamber, S could produce the tone stimulus which had been present in his rearing cage by depressing one side of the cage floor, or the alternate stimulus tone by depressing the opposite side. The side on which a particular tone was presented was alternated each session, and the side presenting a particular stimulus was counterbalanced between Ss within sessions. After six sessions of testing per animal (14 h), the Ss were left in the exposure chamber and all sound was discontinued for 2 weeks. Following this deprivation period, each S was run for four additional 3-h sessions in the test chamber, with silence maintained in the rearing cage. Again, length of time in each tone was recorded, and the side on which a particular tone was contingent alternated between sessions.

RESULTS

A Treatment by Trials analysis of variance was performed on the data prior to the 2 weeks of silence, and a similar analysis was done on the data from the test period following the silence condition. Sessions were collapsed by twos to control preference for side of floor. Total time scores were converted into percentages of time spent per session in the pulsing tone. The first analysis of the first three sessions indicated no significant differences. In the analysis of the last four sessions, differences between groups were significant ($F = 5.57$, $df = 2/15$, $p < .025$), and a separate analysis revealed no sex differences in response to treatments. The mean percent choice of the pulsing tone over sessions (presented in Fig. 1) indicates

Fig. 1. Mean percent time spent in pulsing tone by differentially reared groups of rats over successive test sessions.

the changes by groups over time. As can be seen in Fig. 1, Groups P and C increased their preference for the pulsing side, whereas Group S's preference for the pulsing tone remained at a lower level. Comparisons between groups on average percent choice of pulsing tone in postsilence sessions by means of *t* tests indicated that Group P was significantly higher in choice of pulsing tone than Group S ($t = 7.28, p < .005$), and that Group C was significantly higher than Group S ($t = 4.76, p < .005$), whereas Group C and Group P did not differ significantly.

DISCUSSION

The results provide some support for an environmental imprinting hypothesis. However, it appears that the effect was confounded by a natural preference for the pulsing tone. Preferences for intermittent stimulation have been reported among other species: Rock, Tauber, & Heller (1965) with guppies, Abercrombie & James (1969) with chicks, and Kagan & Lewis (1965) with infants. The preference usually is indicated by an approach or arousal response. Applying these findings to the present study, it would seem that, for the control group, the pulsing tone was more reinforcing than the solid tone. The stimulus pattern of the pulsing tone would also fit Cairns's (1966)

description of "attention-getting," so that in his theoretical framework this stimulus would have more cue weight contributing to attachment behavior. Preference for the pulsing tone was enhanced slightly by early experience of the pulsing group. Group S, with early experience hypothetically working against a natural preference, responded at approximately a chance level. Possibly the early experience was not powerful enough to overrule completely any innate preferences in this group for pulsing stimulation. A similar stimulus preference by unexposed animals was noted by Sluckin & Fullerton (1969), although the stimuli were visual rather than auditory. Rearing with a naturally preferred stimulus provides relatively less scope for that treatment to increase preference, explaining the lack of significant difference between Group P and Group C. However, the significant difference between Group C and Group S indicates that the nonpreferred stimulus was chosen significantly more as a result of exposure.

A possible explanation of the findings could also arise from an adaptation hypothesis. For example, for Ss adapted to a solid tone, a pulsing tone could be detected as a novel and perhaps aversive stimulus, resulting in a continued preference for

the solid tone. However, the fact that the treatment effect was strongest after 2 weeks of silence would seem to rule against a simple adaptation notion.

Several differences are noteworthy between the present study and that of Cross, Halcomb, & Matter (1967). The present study was more extensive in exposure time (24 h as opposed to 12 h per day) and test time (26 h as opposed to 2 h). Simple stimuli rather than complex were used, and the same stimuli were used from early exposure to test (the previous Es used different selections of Mozart and Schoenberg in exposure and test). The current findings would lend support to the effect of early auditory experience on later preference for auditory stimuli. It would appear that stimulus complexity, especially the rhythms involved in musical selections, may have been important variables in the previous researchers' findings. If such exposure learning occurs in other species, including man, it would provide an interesting perspective on many preferences which could develop as a result of early childhood experiences.

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