

The effects of feeding experience on the response to prey-object extracts in rat snakes*

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The effect of eating mice over an 8-month period was observed to produce a greater response to mouse body surface extract in young rat snakes (*Elaphe*). Two measures, attack tongue flick and attack orientation, were employed. This finding was contrasted with earlier results indicating a wide-spectrum undifferentiated response to prey-object extracts at birth.

Burghardt (1966, 1967, 1968) has shown that a wide variety of nonpoisonous, nonconstricting snakes are born with a predisposition to attack chemical extracts, presented on a cotton swab, obtained from the body surface of animals normally eaten in the wild. Morris & Loop (1969) demonstrated that rat snakes (*Elaphe*) are born with a tendency to attack a very wide spectrum of chemical extracts. Newborn rat snakes were found to attack extracts obtained from animals normally eaten by (*Elaphe*) yet too large to be eaten by the young (rat, chicken) and extracts from animals small enough to be eaten (fish, worms) yet not normally considered prey animals for rat snakes. Dix (1968) employed the actual prey animals and demonstrated an innate geographic variation in response to fish for the genus (*Thamnophis*).

The question of the extent to which this innate preference for some extracts in newborn snakes can be modified by experience has received some attention. Burghardt & Hess (1968) demonstrated that force feeding young garter snakes (*Thamnophis*) for a period of 6 months did not affect the preference exhibited at birth or result in any preference for the material, strained liver baby food, which was used as the feeding substance. Burghardt (1969) fed garter snakes (*Thamnophis butleri*) horse meat covered with worm extract for 6 months with progressive decreases in the amount of worm extract. A subsequent test showed that the horse meat extract received the highest score despite the fact that horse meat is not a natural food item of garter snakes. The present study was undertaken to investigate the effects of 8 months' feeding experience with mice on the response of young rat snakes to various prey-object extracts.

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METHOD

The Ss (N = 8) were the offspring of an interracial mating between a male yellow rat snake (*Elaphe obsoleta quadrivittata*) from South Florida and a female black rat snake (*Elaphe obsoleta obsoleta*) from East Tennessee. The Ss were a mixture of two clutches of eggs laid by the female in the same year. Some of the Ss had been tested at birth for extract preferences. All Ss were housed together prior to the study and fed an exclusive diet of laboratory mice. The only exception to this feeding procedure was when the snakes occasionally ate one another. Two weeks prior to the experiment Ss were moved to individual cages and maintained on ad lib water and one mouse per week. At the time of the study Ss were either 244 or 187 days old and had a mean weight of 23.0 g.

The stimulus items were distilled water, goldfish (*Carassius*), frog (*Rana*), worm (*Lumbricus*), laboratory rat, adult and baby laboratory mouse, baby chick (*Gallus*), and insect (*Gryllidae*). Preparation involved placing the whole

stimulus prey object in 50°C distilled water (10 ml per 1.5 g body weight) for 1 min. The prey object was removed, and the remaining aqueous solution was then centrifuged at 2,000 cps for 10 min and refrigerated until use the following day.

The Ss were tested 5 days food deprived and 12 h water deprived. Illumination during the experiment was provided by a 40-W red light. The time between stimulus presentations for each S was 30 min. On a given trial, a cotton swab dipped in extract was placed 1 cm in front of the S's snout. If no attack occurred within 30 sec, the swab was moved slowly forward until it touched the S's snout and then removed to 1 cm. A single trial lasted 90 sec, during which the number of tongue flicks were counted, and the time of the first tongue flick away from the swab was noted. If an attack was made, the trial was terminated and the latency recorded to the nearest second. Each S received one presentation of each stimulus item, with stimuli presentation systematically balanced with a Latin square design. A blind control was employed by assigning letters to the stimulus items so that the E had no knowledge of which stimulus was being employed on a given trial.

The effectiveness of stimulation by a given extract was evaluated with two measures. The first was Burghardt's formula, which is the maximum number of tongue flicks emitted by an S to any stimulus, plus the length of a single trial, minus the latency of attack in seconds. If no attack occurred, the number of tongue flicks was taken as the stimulating value of the swab. The second measure, orientation time (Loop, 1970) was defined as the time

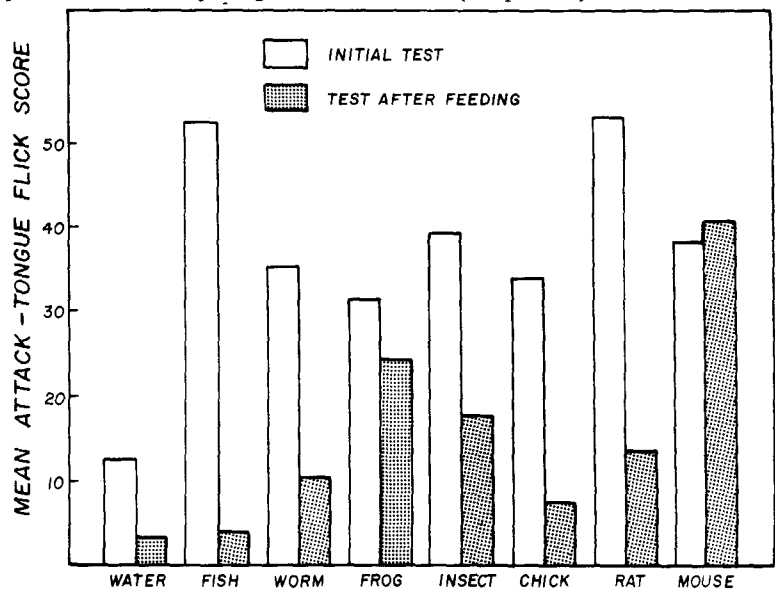


Fig. 1. Mean attack-tongue flick scores at birth and following 8 months' feeding experience with mice.

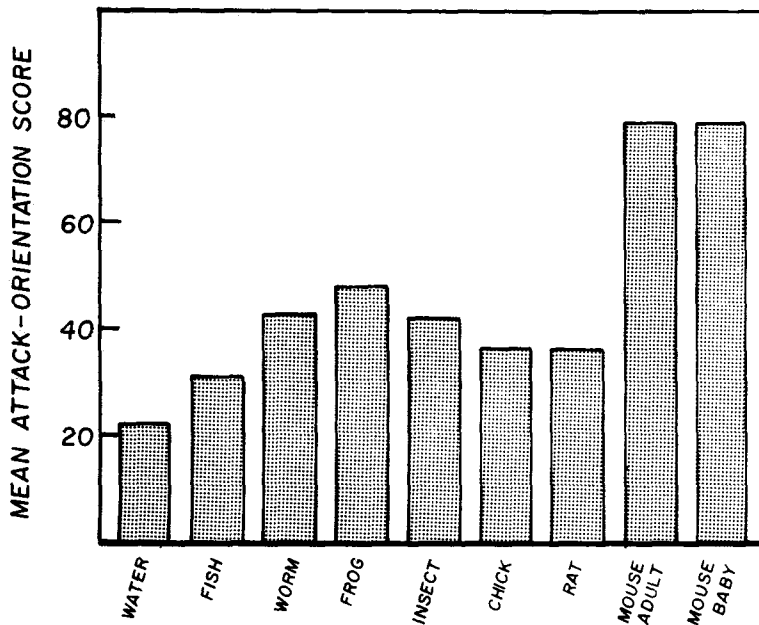


Fig. 2. Mean attack-orientation scores following 8 months' feeding experience with mice.

between the first tongue flick and the first tongue flick that fell at least 2 cm away from the swab. If an attack was observed, the orientation time was taken as 90 sec (maximum possible in any trial without an attack) plus 90 sec minus the latency of attack. If no attack occurred, the time between the first tongue flick and the first tongue flick away from the swab was taken as the orientation time.

RESULTS

During the 72 trials only three attacks were observed. The adult mouse extract elicited two, while the baby mouse extract elicited one. The mean latency of these attacks was 15.6 sec. For the remaining 69 trials, the number of tongue flicks for a single trial ranged from 0 (seven trials) to 54 (one trial). The mean attack/tongue-flick scores for each stimulus item are presented in Fig. 1. The shaded bars represent the scores obtained during this study, while the open bars represent the scores obtained by Morris & Loop (1969) 13 days after birth. For purposes of data presentation and statistical analysis, the attack/tongue-flick scores for mouse extracts were combined and averaged. The observed scores for adult and baby mouse in this study were 42.5 and 39.2, respectively. The remaining extracts received scores of 23.9—frog, 17.7—insect, 13.6—rat, 10.2—worm, 7.5—chicken, and 4.0—fish. The control swab of water received the lowest score of 3.3. A Friedman multi-sample test (Bradley, 1968) was performed on the raw scores. The prey-object extracts were reliably different from one another ($S = 1,013$,

$p < .01$). A Wilcoxon signed-rank test was then performed between the average for mouse and the average of the remaining extracts (water not included). The mouse extract was found to be reliably more effective than the other stimuli ($W_0 = 0$, $p = .003$). The orientation scores without attacks ranged from 90 sec (15 trials) to 0 sec (6 trials). The mean attack-orientation scores are presented in Fig. 2. The mean attack-orientation scores for adult and baby mouse were identical, 78.8. The mean attack-orientation scores for the remaining stimuli were: frog, 48.3; worm, 43.1; insect, 42.3; chicken, 36.0; rat, 35.5; and fish, 30.6. Water received the lowest mean attack-orientation score of 22.2. A Friedman multi-sample test revealed that the extracts were reliably different ($S = 426$, $.05 < p < .10$). A Wilcoxon signed-ranks test found the average attack-orientation score for mouse reliably greater ($W_0 = 1$, $p = .007$) than the average score of the remaining extracts (water not included). A Kendall rank-order correlation test revealed a rank-order correlation between attack tongue flick and attack orientation of .78 ($S = 22$, $p = .005$).

DISCUSSION

The initial test, occurring just after birth, revealed no reliable difference between the stimulating value of the prey-object extracts, although all were reliably more effective than the control stimulus of water. The present study, however, demonstrates a clear preference for mouse, which received the fourth largest attack/tongue-flick score on the

initial test. During the initial test attacks occurred to rat, fish, mouse, frog, and worm. However, during the present study attacks occurred only to mouse. Furthermore, a reduction in the attack latency from 40.2 to 15.6 sec was observed.

An important point is the direction of change in the releasing effectiveness of each stimulus. All extracts except mouse showed a decrease in attack/tongue-flick scores, while the mean scores for mouse extract are virtually identical in the initial and postfeeding tests, 38.5 and 40.5, respectively. This would seem to lend support to the interpretation that the initial scores reflected an undifferentiated attack tendency since actual feeding maintained the effectiveness of mouse extract with a concurrent drop in the scores for the other stimuli. Unfortunately, attack-orientation measures were not made at the initial test. It is clear, however, that this measure also reflects a strong mouse preference.

While mouse proved to be the most effective extract following 8 months of feeding experience, the other extracts all remained more effective than water. A similar effect was observed by Burghardt (1969) following his masked feeding of horse meat to *Thamnophis butleri*. Eventually the horse meat extract was most effective; however, the extracts effective at birth remained effective. This preference for what is available coupled with a retained preference, as compared to water, for what might be more available in the future has clear survival value.

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