

These results show that the method of toe-clipping should be renounced in the future.

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Strike-induced chemosensory searching is absent in *Anolis carolinensis*

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Strike-induced chemosensory searching (SICS) is a squamate behavior consisting of a combined increase in the tongue-flicking rate and searching behavior involving locomo-

tion that occurs after a prey item has been bitten and then escapes, is released, or removed from the mouth. The increase in tongue-flick rate is referred to as poststrike elevation in tongue-flicking (PETF) (Cooper, 1991). SICS presumably helps lizards find and follow scent trails of released or escaped prey (Cooper, 1989a) and may aid in the location of other individuals of the same prey type that may be in the immediate vicinity (Cooper, 1991). This paper reports an experimental examination of the possible presence of PETF and SICS in a polychrid lizard, *Anolis carolinensis*, the green anole.

SICS has been demonstrated in two species of nonvenomous snakes that do not use a strike-release-trail strategy (Cooper et al., 1989), and in several species of lizards including a varanid, *Varanus exanthematicus* (Cooper, 1989b), a cordylid, *Gerrhosaurus nigrolineatus* (Cooper, 1992a), and a lacertid, *Podarcis muralis* (Cooper, 1991). From these findings Cooper (1989a) hypothesized that SICS may occur in any squamate that uses the lingual-vomer nasal system extensively during foraging.

The family Polychridae, which includes the anoles, is part of the iguanian radiation (Camp, 1923; Estes et al., 1988), which consists primarily of sit-and-wait foragers, that have long been believed to use visual, rather than chemical cues in social behavior and feeding (e.g., Evans, 1961; Burghardt, 1964; Cooper, 1989c). *Anolis carolinensis*, like other polychrids, is a diurnal, insectivorous, sit-and-wait forager (Wiles et al., 1990; Burghardt, 1964), that forages on vertical surfaces (Moermond, 1979).

The ability to discriminate prey odors in lizards is correlated with foraging mode and may be important to many lizards in locating and identifying prey (Cooper, 1989b). Discrimination of prey chemicals from control stimuli mediated by tongue-flicking appears to be present in active foragers (Cooper, 1989b, c; 1990a, b), which move through the environment while seeking their prey, but absent in several families of insectivorous sit-and-wait foraging lizards: Phrynosomatidae, Polychridae, Chamaeleonidae and Tropicuridae (Cooper, 1989a, c; Simon et al., 1981; Curio and Mobius, 1978; DePerno and Cooper, unpublished data), which remain immobile much of the time while foraging.

Strict ambush, or sit-and-wait foragers, do not tongue-flick while remaining immobile at foraging posts (Simon et al., 1981; Cooper et al., in press), but instead rely on visual cues to detect prey (Cooper 1989b, c; 1990a, b; 1991). In contrast, members of actively foraging families rely on tongue-flicking to sample prey chemicals while moving through the habitat to detect prey (Evans, 1961). Thus, the lingually mediated ability to discriminate prey chemicals is positively associated with the active foraging mode at the familial level (Cooper, 1990b). Cooper (1992b) therefore predicted that SICS and PETF may be absent or reduced in lizards that do not discriminate prey chemicals from control substances and do not use the tongue to detect chemical prey cues while foraging. Here, we predicted that *A. carolinensis*, which has already been shown to lack prey chemical discrimination (Cooper, 1989c), also lacks PETF and SICS.

The twelve adult *A. carolinensis* used in this study were obtained from a commercial dealer. Each was housed individually in a 30 × 16 × 9 cm plastic terrarium with a ventilated plastic cover. The ambient room temperature was maintained at 24-26°C

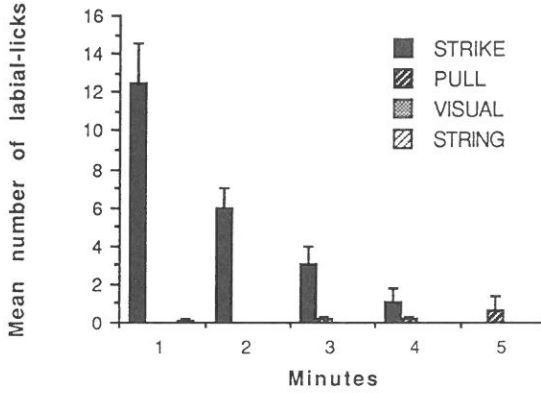


Figure 1. The mean number of labial-licks emitted by *Anolis carolinensis* in each of the five minutes following removal of the experimental stimuli.

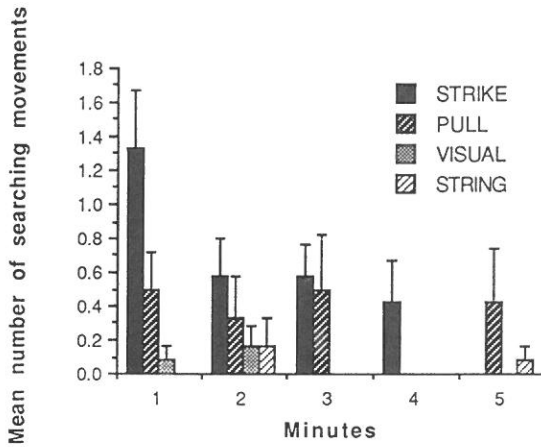


Figure 2. The mean number of searching movements exhibited by *Anolis carolinensis* in each of the five minutes following removal of the experimental stimuli.

under a 12:12 LD cycle. Each lizard was allowed at least three weeks to become habituated to the experimenter and the laboratory conditions. Water and food were available *ad libitum*. Each lizard ate normally following all experimental trials.

A standardized experimental design for detection of PETF and SICS in squamates that do not voluntarily release bitten prey was used (Cooper, 1989a, 1991; Cooper et al., 1989, 1992b). Twelve adult *A. carolinensis* were tested in a partially counterbalanced order in four stimulus conditions using live crickets (*Acheta domesticus*) as prey. Stimuli were presented for a maximum of 15 seconds in each condition. After removal of the experimental stimuli, numbers of tongue-flicks and labial licks (licking of the anterior

and lateral labial scales, Cooper, in press) were counted and putative searching movements were recorded for five consecutive minutes. All locomotion after prey had been bitten and removed was considered to represent potential search for prey. To ensure consistent feeding motivation the lizards were not fed for three days prior to being tested in each experimental condition.

Data for PETF and SICS were not normally distributed due to the presence of many zero values and the variances were intractably heterogeneous. Therefore, data were analyzed nonparametrically as in Cooper (1991).

Results

Anolis carolinensis did not tongue-flick in any condition. The lizards performed numerous labial-licks, primarily in the strike condition and decreasing rapidly from a mean of slightly over twelve in the first minute to zero in the fifth minute. Few labial-licks were observed in the other conditions (fig. 1). Locomotion was infrequent in all conditions. It was somewhat more frequent in the strike and pull conditions than in the visual and string conditions and most frequent in the first minute of the strike condition (fig. 1).

The main treatment effects for labial-licks in minutes one and two were highly significant (minute 1, $\chi^2_r = 21.68$, $df = 3$, $p < 0.001$; minute 2, $\chi^2_r = 18.15$, $df = 3$, $p < 0.001$). There were significantly greater numbers of labial-licks in minutes one and two in the strike condition than in the pull condition, the visual condition, and the string condition ($p < 0.001$ for each). There were no significant differences between other pairs of conditions. Differences in labial-licks among conditions for minutes 3-5 were not significant (minute 3, $\chi^2_r = 6.23$, $df = 3$; minute 4, $\chi^2_r = 1.43$, $df = 3$; minute 5, $\chi^2_r = 0.15$, $df = 3$).

The main condition effect for movement (fig. 2) in minute one was significant ($\chi^2_r = 9.80$, $df = 3$, $p < 0.05$, one-tailed). Significantly more movements occurred during minute one in the strike condition than in the pull condition ($p < 0.05$, one-tailed), in the visual condition ($p < 0.002$ two-tailed), and in the string condition ($p < 0.001$ two-tailed). No other differences were significant between pairs of conditions. Differences in movement for minute 2-5 were not significant (minute 2, $\chi^2_r = 2.08$, $df = 3$; minute 3, $\chi^2_r = 4.68$, $df = 3$; minute 4, $\chi^2_r = 1.35$, $df = 3$; minute 5, $\chi^2_r = 0.55$, $df = 3$).

Discussion

The lack of tongue-flicking by *A. carolinensis* demonstrates the absence of PETF and SICS. The occurrence of a greater number of labial-licks and subsequent searching movements exhibited by *A. carolinensis* (figs. 1, 2) does not indicate the presence of SICS. Labial-licking may result in chemical stimulation of the vomeronasal system (Graves and Halpern, 1989), but it does not aid in the search for chemical stimuli on environmental substrates that might lead to relocation of prey.

The rarity or absence of tongue-flicks, as demonstrated by *A. carolinensis* stands in marked contrast to the frequent tongue-flicking in similar experiments with actively

foraging scleroglossan lizards that demonstrate prey chemical discrimination, PETF, and SICS e.g. Von Achen and Rakestraw, 1984; Nicoletto, 1985; Cooper, 1989b; 1990a, b, 1991; 1992a, b; Cooper and Vitt, 1989). On the other hand, the lack of tongue-flicking in *A. carolinensis* is similar to its rarity or absence in other ambush foraging iguanian lizards (Curio and Mobius, 1978; Simon et al, 1981; Cooper, 1989c; Cooper, in press; Cooper et al., in press). Our findings in the experiment on PETF differ from those in a study of prey chemical discrimination by *A. carolinensis* (Cooper, 1989c). In the latter study 6 of 12 individuals tongue-flicked, but only 1 of 12 labial-licked. Most labial-licks observed in our study appeared in the strike condition after the prey item had contacted the labials and the oral epithelium, whereas the cotton swab bearing prey chemicals did not contact either in the earlier study. This suggests that oral labial contact stimulates labial-licking, which is often observed after eating (Cooper, in press). The function of labial-licking is unknown, but it may serve as a means of chemically sampling the labials or as a cleaning behavior.

Although *A. carolinensis* does not tongue-flick prey prior to attack (Burghardt, 1964; DePerno, unpublished observations), it is possible that the vomeronasal system is involved in the foraging behavior of some species of iguanian ambush foragers. Several species of ambush-foraging phrynosomatid lizards sometimes tongue-flick a substrate immediately after movement (Simon et al., 1981; Cooper et al., in press). This might allow the lizards to gauge the food quality or determine the presence of predators or conspecifics within that particular patch. However, it is unlikely to be important in species that ambush prey from perches in microhabitats that differ from those occupied by the prey (e.g., anoles ambushing ground dwelling arthropods from tree trunks, Moermond, 1979).

The movements exhibited by *A. carolinensis* appeared to allow the lizard to better view the experimenter and did not appear to be attempts at locating lost prey. They did not resemble the continuous movements exhibited by many of the actively foraging scleroglossan lizards (Cooper, in press), consisting instead of quick abrupt turning movements. As anoles are ambush foragers that remain immobile while searching visually for prey, it is possible that these movements serve to change the field of view to increase the likelihood of detecting the prey indicated by chemical stimuli sampled by labial-licking. If so, chemical stimuli might still be important to prey-specific visual search, although PETF and SICS are absent.

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