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Tail rattling and agonistic behavior in mice: Coincidental or causal?

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Twenty-four male mice of the F_1 generation of a cross between C57BL/10J X SJL/J mice were weaned and placed either with siblings or isolated immediately until testing. At 65 days of age, subjects were assigned to one of four arena testing situations; alone, alike, different, and none. In addition, leukocyte counts were obtained for all subjects after behavioral testing. Contrary to previous research, the results showed that there is no significant relationship between tail rattling and agonistic behavior. Furthermore, a sequential analysis performed on the interaction of two animals demonstrated that tail rattling does not serve a communicative function. The data strongly suggest, however, that tail rattling is an indicator of stress as measured by white blood cell count. Implications for the use of appropriate phenotypes in behavior-genetic analysis are discussed.

In some of the more than 100 studies conducted in recent years on the aggressive behavior of mice (Sprott & Staats, 1975) researchers have delineated several specific components of the agonistic behavior sequence. One of the more frequently mentioned components of this sequence has been tail rattling behavior. The apparent causal relationship between tail rattling and agonistic behavior has been well documented. Scott (1947) first referred to tail rattling as an emotional reaction to fear, hypothesizing that tail rattling was a nonmodifiable behavior which served as a warning signal and thus might inhibit fighting by eliciting retreat in the non-tail-rattling mouse. On the other hand, Southwick and Clark (1968) view tail rattling as the component of the agonistic behavior sequence which elicits fighting. Specifically, these authors only recorded tail rattling which occurred *prior* to fights and attacks. No mention is made in Southwick and Clark's report of any instance of tail rattling which may have occurred during or after a bout. In addition, Beeman (1947) and Bauer (1956) used the frequency of tail rattling as a parameter of aggressiveness in mice.

Tail rattling has also been described as a signal—a form of communication in mice. Scott and Fredericson (1951) have postulated that tail rattling functions as a signal to inhibit fighting in mice. In this perspective, tail rattling is described as a threat signal. St. John (1973), on the other hand, views tail rattling as a signal which elicits fighting in mice. Conclusive evidence to suggest that tail rattling is perceived by other mice as a form of communication has been lacking. The purpose of this study was to investigate the function of tail rattling behavior, especially with regard to agonistic and communicative behavior.

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METHOD

Twenty-four male mice of the F_1 generation of a cross between two highly inbred strains: C57BL/10J (♀♀) and SJL/J (♂♂) were tested. A hybrid stock was used because interstrain matings typically result in litters which are larger and more numerous than those obtained from intrastrain matings. In addition, the individuals of a hybrid stock, like those of an inbred strain, are genetically identical. The particular strains used were chosen on the basis of their availability in the laboratory and on their previously observed tail rattling behavior (Hahn & Haber, in preparation). At 21 days of age, all of the mice were weaned and placed into one of two rearing conditions: (1) a socially isolated condition, i.e., no contact with siblings after weaning; (2) a pair-reared condition, i.e., housed with another male littermate until testing at 60-65 days of age. Within each rearing group, the mice were tested in one of four arena situations: (1) Alone; (2) Alike—mice of the same rearing condition were tested in pairs; (3) Different—mice of different rearing conditions were tested in pairs; (4) None—mice in this condition were not tested in the arena.

Mice were tested in an arena constructed from black Plexiglas, 20 cm square with sides 20 cm high. A 2.5-cm square wooden cube, painted with four black and white alternating squares to a side, was placed in one corner of the arena. Mice were observed in the arena situation for 15 min. Four behavioral categories: tail rattling, cube exploration, social exploration, and fighting and two time measures: latencies to tail rattling and fighting were recorded with the use of an Esterline-angus event recorder. After behavioral testing, the mice were returned to their home cages and 15 min later leukocyte counts were taken. The procedure for leukocyte counts has been described elsewhere (Simmel, Wright, & Smith, 1974). These white blood cell counts share an inverse relationship with the production of adrenal corticosteroids.

RESULTS AND DISCUSSION

Figure 1 shows the mean scores, by condition, of the fighting and tail rattling frequencies. The similarity of relationships within the different conditions over both measures should be clear.

To test the order of behaviors involved in the

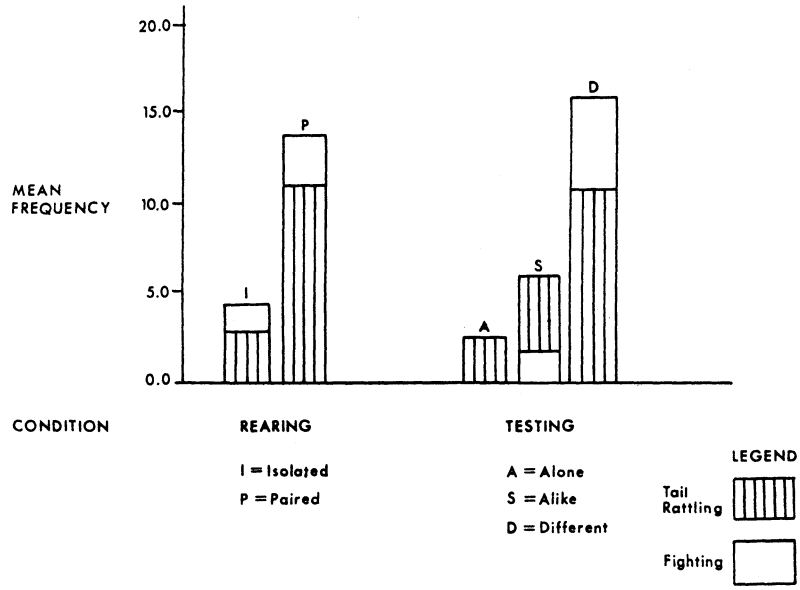

Figure 1. Tail rattling and fighting frequencies by condition. The mice tested in the Alike condition tail rattled more than they fought. Those mice in the Alone condition could not fight, but they did tail rattle.

interaction of two mice, those tested in the alike and different testing conditions, we ran a sequential analysis. A sequence was defined as an initiating behavior by one animal followed within 3 sec by a responding behavior of another animal. The frequencies of initiating and responding behaviors are placed into an n by n matrix, where n = the number of behavioral categories used. Examination of such a matrix makes it possible to identify exactly which behaviors preceded or followed any other behavior. In Table 1, we can see that, in general, the occurrence of tail rattling either before or after fighting was unusual. Within the alike condition, tail rattling *never* preceded or followed fighting. In the different testing condition, only 6% of all tail rattling preceded fighting and 6% followed fighting. The percentages of tail rattling preceding and following the no-behavior category, that is tail rattling either preceded or followed within 3 sec by no observable behavior, are quite high. In addition, the amount of residual tail rattling, that is tail rattling preceded and followed by tail rattling emitted by the same animal, is relatively high.

These results, in combination with the fact that tail rattling occurred in mice in the alone testing condition, suggest that tail rattling is not a major component of the agonistic behavior sequence. In addition, there was no significant correlation (r_{pb} = .38, $t(18) = 1.73$, n.s.) between fighting and tail rattling. Recalling the similarities in frequency between fighting and tail rattling shown in Figure 1, we would have to say that these relationships are more coincidental than causal. Tail rattling did share a significant inverse relationship to leukocyte count (rho = -.57, $t = -2.93$, $p < .05$). The higher the tail rattling frequency, the lower the leukocyte count of an animal, indicating the likelihood that the animal was stressed.

A number of informal observations we made of tail rattling are also pertinent at this time. During the course of pilot work, tail movements, independent of body movements, were observed in mouse pups 14-17 days of age. Tail rattling was observed in weanling 21-day-old mice reared in isolation. Adult mice frequently tail rattled during the process of changing and cleaning their home cages. Finally, several instances of tail rattling were observed in nonfighting adult female mice.

It appears then, that tail rattling is most likely an involuntary behavior of the mouse which is elicited by stressful stimuli, as suggested by our leukocyte measures. The threshold for tail rattling is affected by the type and intensity of the stimulation. It is the relationship between stress and fighting, rather than

Table 1
Results of Sequential Analysis for Tail Rattling Behavior Presented in Percentages

Testing Condition	Initiating Behavior	Responding Behavior: No Behavior	Tail Rattling	Social Explor.	Fighting
Total Frequency of Tail Rattling Collapsed Over Two Trials = 87 Residual = 21%					
Alike	No Behavior		18		
	Tail Rattling	34	0	12	0
	Social Explor.		15		
	Fighting		0		
Total Frequency of Tail Rattling Collapsed Over Four Trials = 249 Residual = 28%					
Different	No Behavior		10		
	Tail Rattling	35	6	4	6
	Social Explor.		4		
	Fighting		6		

that between fighting and tail rattling, which is probably responsible for the frequent observation of this type of behavior in agonistic situations. Moreover, we have observed that tail rattling is *not* specific to agonistic behavior and the sequential analysis demonstrates that this form of response is not responded to by other mice in any communicative sense.

It seemes to us that the broadest implications of this study lie in the need to apply care in the specification of behavioral phenotypes. Specifically, our results suggest the need for a re-examination of the components of the agonistic behavior sequence in mice. Tail rattling appears to be incidental to agonistic behavior, serving neither a causal nor a communicative function.

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