THE BEHAVIOR OF WHITE RATS IN THE PRESENCE OF CATS

COLEMAN R. GRIFFITH

Psychological Laboratory, University of Illinois

The recently reported note¹ on the possible instinctive character of the behavior of the white rat in the presence of a cat has led to a more complete and accurate description of the facts. At the time the note was written it had been observed that the presence of a cat, or of the feline odor when carried on the hands, was a signal for the release of a striking bit of behavior in the rat. Because of the apparent unlearnedness of the responses, it was thought best to call them "instinctive." Small² has given the first controlled description of such activities in the white rat; but further work has by no means kept pace with descriptions of other kinds of behavior aroused during the laboratory use of these animals.³

The behavior previously described suggests Small's account of the "emotional response of fear" at unusual noises (p. 86). "Fear in connection with loud noise is more definitely determinable (twenty-second day); besides the reflex recoil, they crouch and huddle together and wear a subdued expression" (p. 87). Small did not find, however, that this behavior was excited by the presence of a cat or by the feline odor. "The young rats showed not the slightest symptom of fear of either man or cat, though I tested them almost daily by my own presence and by presenting my hand to their noses after having impregnated my

¹ Griffith, C. R., A possible case of instinctive behavior in the white rat. *Science*, 1919, 1, 166-167.

² Small, W. S., Notes on the psychic development of the young white rat. *Amer. J. of Psychol.*, 1889, xi, 80-100.

³ See Donaldson, H. H., *The rat*, 1915, p. 28, for a bibliography of references to early accounts of the behavior of rats under natural conditions, and to later laboratory work.

hand with cat-odor by rubbing a cat" (p. 98). He did find, however, that adult rats with no experience showed some uneasiness, which, with other facts, led him to think that "the manifestation of instinctive fear waits upon the integration and functioning of the higher centres" (p. 99).

The problem is not solved. It calls for experimental isolation, further description of the performances previously noted, and a determination of the specific relation between the responses and the presence of the cat. Several questions should then be answerable: to wit, (1) What is the chief sensory channel through which the responses are induced, i.e., what is the specific factor in a cat that should excite such behavior? (2) What relation obtains between the response and the age and sex of the rats? (3) What is the relation of this type of behavior to other well-known types of behavior?

For further work, five groups of docile white rats, varying in age and sex, and three females with litters, were used as subjects. Five cats, two dogs, a variety of odorous chemicals, and some mice and common Norway rats, were used to excite the responses. In a part of the experiments, the rats were undisturbed in their nests on an iron frame, the exciting object or substance being placed upon or in their cages after it had been brought into the room. In this way, a minimal disturbance in the normal living conditions was hoped for. In another part of the experiments, the rats were taken, singly or in pairs, to the object provided in another room. For this purpose a wire puzzle-box was used to hold the rat. Over the puzzle box was set a large glass observation-frame inside of which the cat or other object could be placed.

In the first group of experiments, an effort was made to isolate the responses and to give a complete description of them. Two female rats about five months old were placed in the puzzle-box. As is usual with normal rats, they began vigorously to explore the new environment. In all experiments of this kind care was taken to note the immediacy and the energy of this initial exploration. Within a second or two after the introduction of a cat under the large observation frame, the subjects suddenly dupli-

cated the performances previously reported. The exploratory movements were totally inhibited. The otherwise tense position of the rats was varied by a slight trembling and a sort of spasmodic contraction in the region of the viscera. The whole attitude of the rats seemed to indicate fear. At the end of five minutes, the cat was removed. During this time the rats had not changed their tense position, the head being held up and out, the feet planted squarely on the floor, the body slightly crouching, the respiration accelerated for a few moments and then momentarily retarded.

In another series, the rats were left undisturbed in their nests, the cats being brought into the room and placed upon the cages or within them as the circumstances warranted. The behavior of the groups was still more striking than had been the case with the single rats or with the pairs. In the first trial, a cat was placed on the cage containing the five-months-old rats. Within a few seconds, activity had completely ceased in the cage and within thirty seconds all the rats, save one (described below), had retreated to one corner of the cage and were there massed together. Some of the rats were displaying the same convulsive movements of the viscera, and occasionally a low whine was detected. When the cat was placed upon the cage containing the two-months-old group, the responses were more intense than in the previous case. There was considerable nervous jumping. The huddling together would last for a few seconds, and then, as some noise or some movement of the cat occurred, the rats would run distractedly here and there and finally collect again in a corner. A mother and two young about four weeks old confirmed previous observations. The young seemed very much disturbed and did not recover for more than two hours. The mother retreated to one corner of the cage and remained there for over an hour. Another female was suckling a litter of five young, about two weeks old, when a cat was placed upon her cage. She hastily left the nest and backed to the rear of the cage with the same characteristic performance. A mother caring for a litter of nine, which were one day old, likewise hastily left the nest dragging three of four young with her. She crouched at

the back of the cage with all the indications of fear. About fifteen minutes after the cat had been removed and efforts made to dissipate the feline odor in the room, the mother of the very young litter undertook in a hesitating and furtive way to return to the nest some of the young which had been lustily crying. She did so by seizing them in her teeth and depositing them one by one in the nest in the forward part of the cage. She frequently retreated to the rear of the cage, however, and assumed the old posture. At the end of thirty-five minutes all the young had been returned and the mother was beginning to resume her usual behavior. It was nearly an hour before the mother of the two-weeks-old litter had fully recovered. In a little over an hour the two cages of adult individuals had quite recovered, their normal feeding activities being interrupted now and then by only a slight reversion to the old attitude. These observations were further confirmed by four other cats and by repeated trials.

Now the writer has noticed that when young rats have not been handled at all until they have just opened their eyes and they are then picked up, they make violent efforts to escape. There seems here to be an unlearned response to an unusual or strange situation. The question arises, therefore, as to whether or not the responses to the cat are not usual responses to any new situation,—the newness or the strangeness itself being the essential point. The experimental procedure that has been detailed in the foregoing was, therefore, repeated with two dogs, several chemical substances, and other odors. The behavior of the dogs was quite different from that of any of the cats. There were frantic efforts to get at the rats, large amounts of saliva being secreted and dropped about the cages and the floor. The disturbance made was so great as to excite the rats, but there was nothing qualitatively characteristic about this excitement. The same sort of behavior on the part of the rats,—a running to and fro about the cage, etc.,—can be produced at any time by disturbing the nest and cage in a similar manner. Moreover, there is no after-effect, the rats resuming their normal activities as soon as the dog is removed. The use of a number of chemical odors, including ether, alcohol, carbon disulphide,

stale cheese, syrups of various fruits, heliotrope, camphor, hydrochloric acid, nitric acid, and a variety of other volatile substances, induced much "prying curiosity," the rats following the odor as it moved back and forth below the front part of the cage. This was the case even when a cloth model of a cat was placed upon the cage in order to simulate the conditions previously established. There was no sign of fear of mice or Norway rats, nor of any part of them, the mice being attacked and in some cases eaten.

There was never anything about the behavior of the rats that would indicate movements of offense or defense. The entire inhibition of exploratory movements has already been mentioned. The behavior reminds one of nothing so much as a sort of paralysis or at least a kind of inertness, possibly the attitude an animal might take when fascinated. One four-weeks-old male was exploring the top of a nest-box when a cat was introduced. The rat immediately "froze" and hung for twenty-two minutes, one toe after another slipping loose, until finally the rat dropped to the floor where it remained on its back and side. The rats made no attempt to resist the experimenter's hand during the persistence of the odor, and, when replaced in the nest, they rested where and in the position they happened to be when set down. The time during which this behavior lasts is striking. As soon as the cats were removed from the observation-frame, the air was changed by currents as rapidly as possible; but the return of the rats to normal movements was very slow. This return, which begins within an hour after the experiment, is marked by half-hearted efforts at cleaning the face or sometimes by a very cautious exploratory movement. Attempts to attract the attention of the rats during this period were futile. The whole organism seemed set in another direction. If, however, they are handled gently for some time, the period of recovery is much shortened. We now come to the questions proposed.

1. It is evident from the foregoing descriptions that the presence of a cat is a definite occasion for the arousal in the white rat of a characteristic cessation of normal movements and activities as measured by the maintenance of a specific posture,

and such other responses as whimpering, increased rate of respiration and heart-beat, and visceral disturbances. Just what the exciting object may be, aside from that expressed by the phrase—'presence of a cat'—cannot be stated. The sense-department involved, however, was established as follows. If a cat is placed upon a cage when the room is wholly dark and five minutes later the light is switched on, (care being taken to keep other conditions normal) a striking tableau is presented of every rat in a group huddled in some corner of the cage and giving evidence of the same behavior as above described. The visual factor, the form and movements of the cat, seems, therefore, to play no essential part. Rats placed in an enclosed space which has previously contained a cat respond as above. The response to the odor carried on the hands or in a damp cloth which has been rubbed for some time over a cat is not so sudden nor so intense but nevertheless striking. There is no response to a cat encased in a glass jar even though the cat makes a variety of movements. One rat (mentioned above) which may have been almost if not entirely anosmic from a pneumonial affection was undisturbed by the presence of the cat; for it displayed much interest in the cat's feet and body as they came in contact with the cage. Three subjects rendered anosmic by cotton stuffed in the nostrils were likewise undisturbed. It seems quite probable, therefore, that an olfactory quality of some sort is an adequate stimulus for the arousal of the behavior described. The rat does not so respond to the lungs, the heart, the blood, the intestines, the feces, the urine, a portion of the abdominal wall, or a section of the muscles of the hind leg of the cat. It probably does respond to the hair, when detached from the body; possibly to the skin, and more definitely to the nose. These portions of the dead cat did not, however, arouse unusual behavior in the rats with any amount of intensity. The temporary conclusion of investigations of this kind is that there is some olfactory quality about the living cat which sets off the responses just described. It is probably safer to describe the behavior itself than definitely to say that it is fear. The work of

Cannon⁴ and others suggest, however, that physiological investigations might furnish a more definite answer to this question.

2. Having in mind age and sex differences, the above experiments were repeated with many pairs of rats and with five different cats. Save for the litters of very young rats, the behavior was so uniform as to obviate the necessity of a detailed presentation, the responses varying chiefly in degree. A few of the subjects whined but all gave unmistakable signs of disturbance. Only five or six displayed the bodily contractions, three being females. There seems to be no sex difference save when the female is pregnant or is suckling a litter. In these cases, the reaction appears a little more marked. The younger rats, especially those two months old, were highly excitable, running nervously from one part of the box to another whenever the cat changed its position. A group three weeks old presented a comical picture. They were hardly strong enough to maintain a rigid position and their eyes were not yet accustomed to the light, having opened only the day before. Their attitude was just as characteristic and specific, however, as that of any of the adults. The performance of the group two weeks old is a little questionable. There was, of course, no bodily posture taken. The judgment had to be made entirely in terms of the amount of activity manifested in squirming about the nest seeking the mother. In the presence of the cat, these movements almost ceased, the quietness being unusual after the cat was removed; but the quiescence was in no other way striking. The day-old group made no response that could be detected even though the nose of the cat was held within 1 cm. of the rats. There was no response from the same group when a week old, nor at ten days. Watson⁵ thinks that the olfactory tract is entirely unmedullated at this age or for some days later. Our results would seem to indicate that the fear-response takes place before such medullation, then, and certainly before medullation in the higher centres has progressed very far.

⁴ Cannon, W. B., *Bodily Changes in Pain, Hunger, Fear and Rage*, 1915.

⁵ Watson, J. B., *Animal Education*, 1903, p. 118, and *passim*.

The behavior of the cats is interesting. None of them was concerned with the rats, save the youngest, which spat and struck when a rat was pushed near her. When placed in the wire cage containing the seven oldest rats, she was entirely indifferent until the anosmic female rat mentioned above essayed to explore too intimately, at which she spat viciously and struck at the rat. From this time on, the female in question evinced more of the behavior of the other rat; but at no time did she seem to be wholly afraid. Although the cats seemed to be indifferent to the presence of the rats, they all sought, captured, and eagerly ate mice which were provided. One only pursued, captured and ate a young rat.

3. We come finally to a statement of the relations this behavior has to certain other well-known kinds of behavior. It has already been made clear that there is a total inhibition of the exploratory movements. The rat seems to possess a very definite and rather well-established tendency to explore in a characteristic way every new situation in which it may find itself.⁶ There has been a total inhibition of all this activity in almost every case. The one exception has been explained. In other words, the neural organization, whatever it may be, which is excited under the influence of the feline odor is prepotent over the neural organization giving rise to exploratory movements. The other tendencies to be taken advantage of are the feeding tendencies, the specific sex tendencies, and the mothering tendencies.

Repeatedly the rats have been allowed to go without food for several hours beyond their normal feeding-time. When food—cracked corn, oats, sunflower seed, and bits of cheese—was finally placed in the nests, the feeding activities were, of course, marked. On these occasions, to put a cat quietly on the cages results uniformly in the inhibition of the feeding activities and in the arousal of the behavior characteristic of the situation. When a male and a female are newly placed together in a cage the usual movements of pursuit and escape are immediately aroused. The introduction of the feline odor results, however,

⁶ Small, *op. cit.*, pp. 99 f.

in the same way. There is an absolute cessation of activities indicative of either tendency for as long as an hour. The inhibition of the mothering activities has been indicated above. After repeated experiment, the mother of the very young no longer left the nest but crouched in a frightened manner over them. This was in no sense protective, but rather identical with the attitudinizing of the other individuals under similar circumstances. Just as striking, was the arousal of the rats from sleep. Forty-one seconds after a cat had been placed upon a cage of sleeping rats, disturbance began. The first indication was the opening of the eyes and the raising of the nostrils in an exploratory manner. Two minutes later all the rats were huddled in a corner of the cage; one was whimpering. In a few seconds, the rats in an adjoining cage were behaving in the same way.

Associations are established very rapidly with these activities. It was noticed as the experiments proceeded that they were carried over to objects originally arousing no such behavior. For some days after a two-weeks experimental session with a two-months-old group, a partial response was excited by the presence of the experimenter himself, or by objects placed upon the cages. With one group of young rats attempts had frequently been made to feed them bits of cheese during the presence of a cat. For several days after the series was over fresh cheese repeatedly excited a marked disturbance. This was especially true when the presentation of the cheese was accompanied by a clucking sound frequently made on other occasions to attract the attention of the rats. The establishment of such associations is quite illuminating in view of the work already done on "conditioned" and "unconditioned reflexes."

To conclude: the experiments here reported demonstrate that there is a specific factor, probably olfactory, about the living cat which induces in white rats of two weeks and older a marked bodily state which is suggestive of fear.⁷ This state can be

⁷ We have found that, in some subjects, this fear-attitude is more like Preyer's cataplexy than like the timidity or cowering observed by Yerkes (Yerkes, R. M., *The heredity of savageness and wildness in rats*, *J. of Animal Behav.*, 1913, 3, 287 ff.). Since the classical descriptions of cataplexy and of "hypnotized

induced either under normal living conditions or at times when the rats are feeding, mating, mothering or sleeping. The demonstrated unlearnedness of the behavior would indicate that it is probably instinctive.

animals" by Preyer (Preyer, W., *Die Kataplexie und der thierische Hypnotismus*, 1878), and (Verworn, M., *Beiträge zur Physiologie des Centralnervensystems*, Erster Theil. *Die sogenannte Hypnose den Thiere*, 1898, Jena, pp. 1-92), much work has been done on the somewhat similar attitudes known as death-feigning. (See Severin, H. H. P., and Severin, H. C., *Behavior Monog.*, 1911, 1, No. 3, pp. 43-44, for a bibliography of these studies). Some of our rats, however, in spite of an apparent rigidity were quite limp and inert when taken in the hand.