Pain-Elicited Aggression and Targeting in Sprague-Dawley Rats

Michael Christiansen

Allegheny College

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Pledge: _____

Approved:

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(Rodney Clark)

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(Jeff Hollerman)

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Abstract

Pain-elicited aggression in rats is a well-studied behavior and while there has been a large amount of research on how rats respond to aversive shock in the presence of conspecific intruders there has been little research about the response to predator intruders. The present study examined how changes in the intruder (either a simulated rat or simulated snake) and corresponding odorant would affect the amount of bite responses when an aversive shock was delivered. The present study examines relevant research on the subjects of tail shock, foot shock, shock-elicited aggression in rats, learned helplessness, and how rats will respond to conspecific and intruder odors. The results suggested, due to there being few bites when the subject was exposed to shock than there were when no shock was present, that foot shock will not elicit biting responses in rats if the intruder is an inanimate object even if the object resembles a conspecific or predator and odorants (conspecific and predator respectively) are present.

Pain-Elicited Aggression and Targeting in Sprague-Dawley Rats

When an electric shock is administered to two animals in an enclosed environment there will often be some type of aggressive exchange between them after the shock. This behavior is known to take place in rats, which will "face one another in an upright position with head thrust forward, mouth open and paws extended, and from this position they strike vigorously with paws and teeth" (Lyon and Ozolins, 1970). While this behavior has been studied in regards to rats attacking other rats (Lyon and Ozolins, 1970; Ulrich and Azrin, 1962; Maier, Anderson, and Lieberman, 1972; Williams, Worland, and Smith, 1990; Thomas, Takahashi, and Barfield, 1983), rats attacking non-conspecific non-predators (Ulrich and Azrin, 1962), and rats attacking inanimate objects (Azrin, Rubin, and Hutchinson, 1968) there has been little research done on pain-elicited aggression when the rat is enclosed with a predator. The present investigation aimed to examine the number of attacks a rat would carry out in the presence of a predator as opposed to a conspecific intruder when a shock was delivered.

If a rat were to be confined with a natural predator it would be difficult to ensure the rat's survival, and so proxies were used for the conspecific (a rat) and non-conspecific (a snake) intruders. It has been found that albino rats have poor eyesight and while being able to determine the shape of an object the rats are unable to see fine details with accuracy (Lashley, 1912). Moreover, albino rats "depend on facial vibrissae and olfaction for sensory input" (Johns Hopkins University, n. d.). Due to rats' dependence on olfactory input odorants were used to make the proxy intruders appear more realistic.

The practice of introducing the odor of a conspecific or non-conspecific intruder by placing bedding that has been soiled by the intruder has been observed to elicit the same behavior as would appear if the intruder was close enough for the rat to smell (Williams and Scott, 1989; Williams, Worland, and Smith, 1990; Perrot-Sinal and Peterson, 1997; Li, Maglinao, and Takahashi, 2004). While in the presence of an odorant from a predator rats respond by reducing locomotive activity or freezing and becoming analgesic without the need of conditioning (Perrot-Sinal and Peterson, 1997; Li, Maglinao, and Takahashi, 2004). Alternatively while in the presence of an odorant from a conspecific rats show none of the behaviors that are displayed while a predator odor is present except in certain situations. To elicit behavior similar to predator odor reactions, the rat may be conditioned to "fear" conspecific odorants by introducing aversive stimuli while the conspecific odorant is present (Williams and Scott, 1989). It is possible for the conditioning to be done in a very short amount of time and while the behavior in the presence of a conditioned conspecific odor and the behavior in the presence of an unconditioned predator odor are not identical, they still share the characteristics of freezing and entering an analgesic state. The other situation in which similar behaviors can be seen is when the rat is in the presence of odorants released from a stressed rat (Fanselow, 1985). Fanselow found that

> "When unstressed Sprague-Dawley or Long-Evans rats were placed in a chamber containing the odor of a conspecific that had received electric shock, they became analgesic ... Nonstressed conspecifics and novel odors produced no such effect."

Odorants for the current investigation were procured by placing a 60% cotton, 40% polyester shirt in the enclosure for a ball python (Python regius) and an identical shirt in the enclosure of

a male Sprague-Dawley rat (Rattus norvegicus) that was not used in the investigation. This step was done in the hope that the subjects in the investigation would behave as if the conspecific and non-conspecific intruders were real.

While it was possible to produce realistic appearing conspecific and non-conspecific proxies and it was possible to introduce odorants from the real versions of the proxies there was no method for recreating the vocalizations of the intruders. Fortunately there is evidence to suggest that the absence of vocalizations do not decrease the chances of aggressive behavior when a rat encounters an intruder (Thomas, Takahashi, and Barfield, 1983). Thomas, et al. (1983) conducted two experiments, in the first of which intruder rats were devocalized so they would be unable to produce the normal ultrasonic vocalizations that generally accompany aggressive exchanges between rats. In the second experiment the defending rat was rendered deaf so it would be unable to hear any vocalizations from the intruding rat. In both of Thomas, Takahashi, and Barfield's experiments there was no decrease in the amount of aggressive behavior between the defending rat and the intruding rat.

When studying pain-elicited aggression the most common aversive stimulus used is an electric shock. The shock may be administered to the foot (foot shock) or tail (tail shock). Most research uses foot shock due to the ready availability of apparatuses with foot shock capabilities. The effect of foot shock on rats has been shown to induce fighting in rats which generally would not attack one another otherwise (Ulrich and Azrin, 1962). Ulrich and Azrin (1962) found that as the frequency of shocks increased there was a higher percentage of shocks followed by an attack. When a single shock was delivered once every ten minutes only 50% of the shocks were followed by some type of attack but when 38 shocks were delivered every

minute 85% of the shocks were followed by an attack. Ulrich and Azrin (1962) also found that rats generally do not attack inanimate objects when a foot shock is administered and that the rats would not attack deceased rats after foot shock was administered unless the dead rat was being moved around the cage. The second form shock, tail shock, has been found to elicit attacks on inanimate objects (Azrin, Rubin, and Hutchinson, 1968).

In the Azrin, Rubin, and Hutchinson (1968) experiment rats were shocked on the tail when a metal, wood, or rubber device was in front of them. The rats were placed in a restraining tube with the target at one of the tube and their tails pulled through the back. The rats' tails were taped to a tail-restraining rod and had electrodes attached to their tails. Azrin, Rubin, and Hutchinson (1968) found that tail shock was an effective means of eliciting biting responses when inanimate objects were the targets and found that the wood target received the most bites while the metal target received the least. Azrin, Rubin, and Hutchinson (1968) made no mention of any need or method for reducing the electric resistance of the rats' tails. Tsuda and Tanaka's (1985) method for tail shock differed from that of Azrin, Rubin, and Hutchinson (1968).

> "The grid floor, which was rubbed with 50% glycerin water containing 3% NaCl to facilitate conduction, was connected to the positive output of a solid-state shocker/scrambler. To complete the electric circuit a tail electrode, which was made of copper plate (1.3 x 3 cm), was connected to the negative output of the shock source. The tail electrode was taped onto the tail approximately 1.5 cm from the base of the tail. The site of the electrode contact of the tail was augmented with electrode paste to reduce electrical resistance." (Tsuda and Tanaka, 1985)

While tail shock was used in Tsuda and Tanaka's (1985) experiment, the purpose was not to study pain-elicited aggression with inanimate objects as the target, but to examine the effects of controllable and uncontrollable shock.

When an animal is subjected to uncontrollable shock for prolonged periods a state of learned helplessness may occur (Seligman, Rosellini, and Kozak, 1975; Maier, Anderson, and Lieberman, 1972; Fanselow and Helmstetter, 1988). Learned helplessness behavior in rats can be observed when a failure to avoid escapable shock that rats that have not been through inescapable shock procedures are able to avoid (Seligman, Rosellini, and Kozak, 1975). Seligman, Rosellini, and Kozak (1975) found that after a single inescapable shock session (Total of 80 15-sec shocks on a VT 1 minute schedule) rats that had been exposed to inescapable shock session failed to avoid an escapable shock 78% of the time while the control rats only failed 34% of the time. Moreover, it has also been found that a history of inescapable shock leads to a decrease in shock-induced fighting (Maier, Anderson, and Lieberman, 1972). When a rat has a history of escapable shock there is only a slight decrease in shock-induced fighting, but when a rat has undergone sessions of inescapable shock, there is a drastic reduction in shock-induced fighting (Maier, Anderson, and Lieberman, 1972). To prevent the acquisition of learned helplessness it is possible to bolster the rat through prior training (Seligman, Rosellini, and Kozak, 1975). In Seligman, Rosellini, and Kozak's (1975) experiment the group of rats in the immunization group (trained to be resilient to learned helplessness) was trained to avoid a shock by jumping to a platform. After the platform training was complete the immunization group rats went through a session of inescapable shock during which the platform that was originally in the chamber was removed. In the third phase of the experiment the immunization

group underwent a session of escapable shock where FR 3 bar press response was needed to avoid the shock. It was found that the immunization group's escape behavior was not affected by the session of inescapable. The immunization group learned the escape behavior just as quickly as the control group (only preformed the third session) and learned the behavior faster than the inescapable group (performed the second and third session). Due to the nature of the current investigation, it was important that the participating subjects did not begin to display the behaviors related to learned helplessness.

The purpose of this investigation is to explore the hypothesis that there will be a greater number of bites when the subject is in the presence of an intruder and a shock is delivered as opposed to the subject being in the presence of an intruder and no shock is delivered. Furthermore, there will be a difference in the number of bites between the conspecific and predator conditions.

Method

Subjects

Six male Sprague-Dawley rats (*Rattus norvegicus*) were used for the experiment. The average weight of the subjects was 255.19 grams with a standard deviation of 15.97 grams. The subjects were 56 to 59 days old at the beginning of testing and 70 to 73 days old at the end. Subjects came from the Allegheny College rat colony. Each subject went through every test condition. Approved by the Animal Research Committee of Allegheny College.

Apparatus

A BRS Foringer 27.94^{cm} by 20.32^{cm} testing chamber was used. The chamber contained a stimulus light, one lever, and a food/water dispenser. Attached to the testing chamber floor was a Digi Bit Shocker-Scrambler. The Shocker-Scrambler was set to give a shock between 0.5 and 0.8 miliamps. Two identical shirts (60% cotton, 40% polyester) were treated with either conspecific or predator odorants and placed in the testing chamber with either the conspecific intruder (15.24^{cm} tall brown rat toy) or the predator intruder (33.02^{cm} long rubber, ball python).

Procedure

To begin each of the six subjects spent two trials in the testing chamber with the conspecific intruder and two trials with the predator intruder while a shirt with odorants of the respective intruder were underneath the testing chamber floor bars. Each session lasted five minutes, during which biting behavior was recorded and no shocks were delivered. Originally it was planned to uses a tail shock method for the trials when shock was to be administered but I device to deliver the shock could not be constructed so foot shock was used instead. During the first shock session the subjects were placed inside the testing chamber with either the conspecific intruder or the predator intruder with the appropriate odorant present and a 0.5 - 0.8 miliamp 0.5 sec shock was delivered through the chamber floor on a VT 15 sec schedule (an average of 20 shocks per session) for five minutes, during which biting behavior was recorded. After each of the subjects had finished testing under either the conspecific or intruder condition the testing chamber was cleaned and prepared to run the second condition. After the first trial

it was found that all but one of the subjects in the conspecific condition froze after three minutes of testing and that no bites occurred in either condition after the three minute mark. For the second and third trial the testing time was shortened to three minutes.

Results

The difference between the number of bites in the shock conditions and the no shock conditions were found to be statistically significant where the alpha level was 0.05(significance for no shock/shock was 0.003) but in the opposite direction than what was originally expected. In figure 1 the conspecific and predator bite averages for the no shock condition (5.42 and 5.58 respectively) and the shock condition (0.5 and 0.6 respectively) are shown.

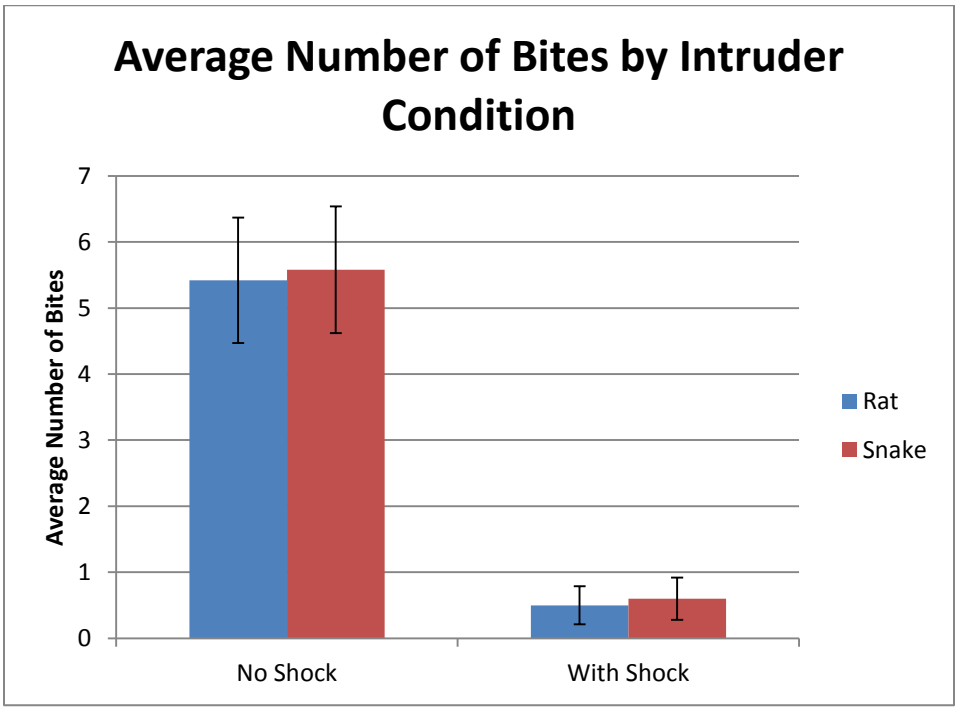


Fig. 1. Average number of bites for both intruder and shock conditions. Standard Error of the Mean is shown.

Figure 2 shows the average number of bites for each subject in the conspecific and predator conditions with no shock and figure 3 shows the same conditions but with shock.

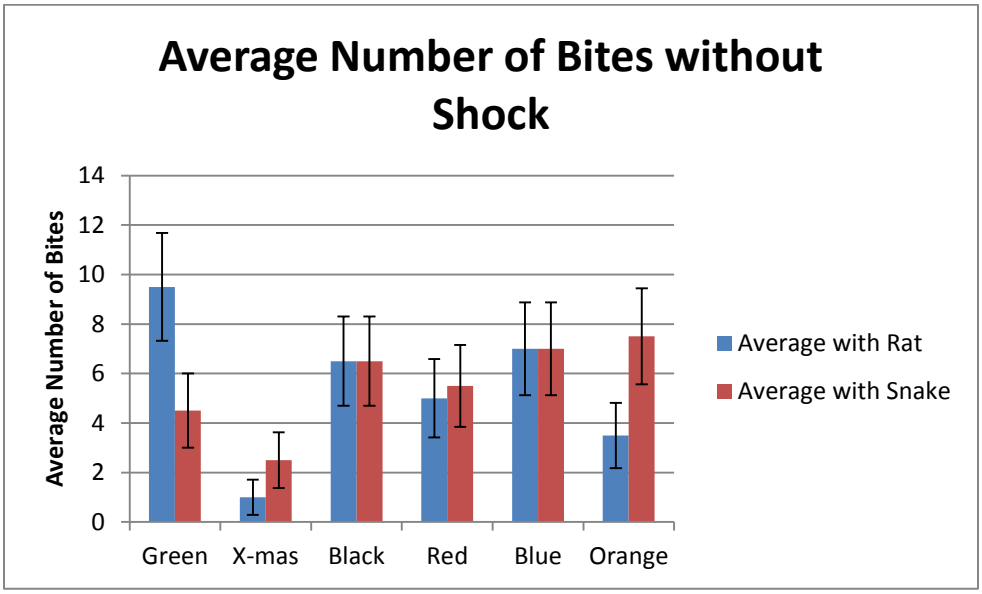


Fig. 2. The average number of bites for each subject (labeled by color) in both intruder conditions without shock. Standard Error of the Mean is shown.

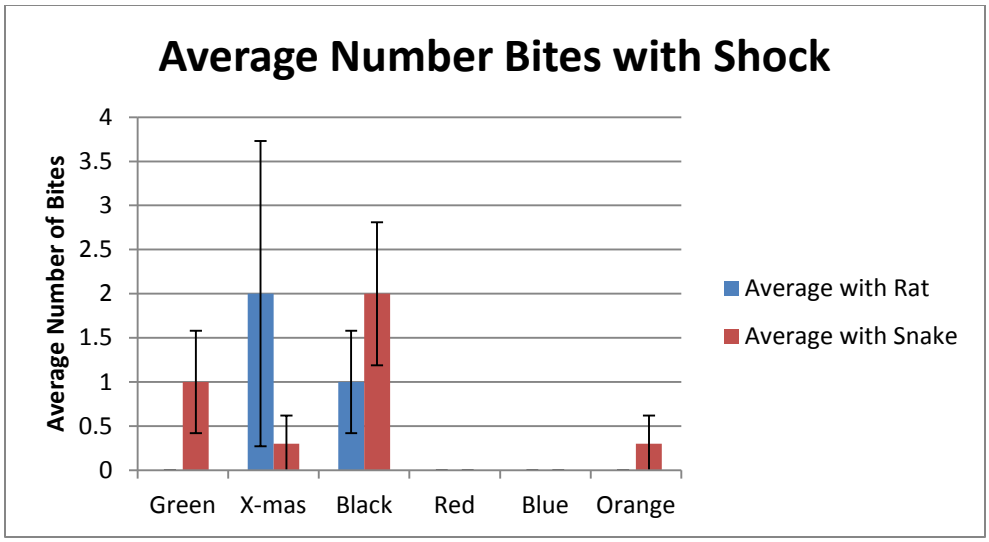


Fig. 3. The average number of bites for each subject (labeled by color) in both intruder conditions with shock. Standard Error of the Mean is shown.

It can be seen that the number of bites decreased drastically when foot shock was elicited. The difference between the number of bites on the conspecific and predator intruders was not statistically significant in the no shock condition or the shock condition. Figure 4 shows the average percent of time that the subjects were moving around the testing chamber in each condition. It was found that the subjects would climb on top of the intruder thus avoiding the shock.

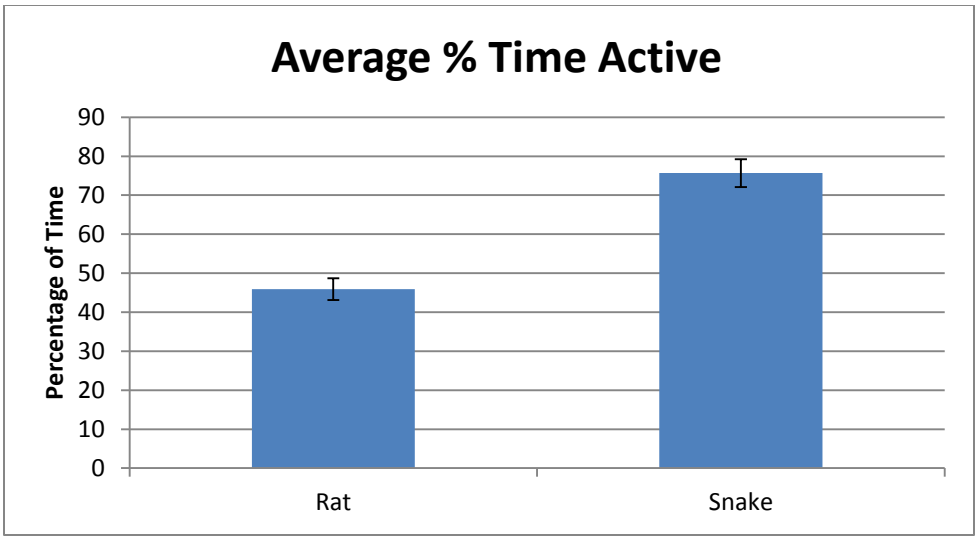


Fig. 4. Average percentage of trial time to pass before subjects froze in conspecific and predator shock conditions. Standard Error of the Mean is shown.

Discussion

While the original aim of the investigation was to compare pain-elicited aggression with a conspecific target to pain-elicited aggression with a predator target little was learned in that regard. The issue that arose was the fact that the subjects treated the intruders as parts of the environment and did not seem to view them as living. There was information to suggest that this would happen (Ulrich and Azrin, 1962), but due to the lack of information on the use of inanimate objects in combination with odorants and the use of inanimate objects that resemble predators it was thought that the subjects might respond in the manner hypothesized (biting the intruders after being shocked).

The results suggest that foot shock will not elicit biting responses from rats even in the presence of an inanimate predator and appropriate odors of the predator. As the investigation was not originally designed to test this further studies are needed.

Tail shock, while the preferable method, could not be used for the current investigation due to the subjects not responding to shock. Originally the shirt with the odorants was placed on the testing chamber floor while the subject had two cusps of aluminum foil (folded over several times) wrapped around the tail. The aluminum cusps were attached to the positive output of the shocker-scrambler machine and the negative output (one cusp per output). When shock was given the subject didn't display any behavior associated with aversive shock. The full range of shock magnitudes was tested but the subject never responded. When tested by a researcher it was found that the aluminum cusps could still transfer the electric shock to the wearer. Because the original hope of the investigation was that the subjects would view the intruders to be living, it was decided to use foot shock in the place of tail shock.

During the final trial of the predator intruder with shock condition it was observed that four out of the six subjects would continue to explore the testing chamber even though shock was being delivered. During conspecific with shock trials all subjects were found to freeze and remain immobile for the duration of the trial. During the beginning of the trial the subjects would climb on top of the predator intruder as they had in the past trials but 23 to 45 seconds in the subjects would climb off of the predator intruder (where they were avoiding the shock) and explore the cage (where they would receive the shock). Even though the same amount of shock was being received as was in the conspecific condition the subjects remained active for the full duration of the trial.

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