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COMMENTARY

Can Aggression in Dogs Be Elicited Through the Use of Electronic Pet Containment Systems?

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Five cases are described that involve severe attacks on humans by dogs who were being trained or maintained on an electronic pet containment system. The system is designed to boundary train a dog through the use of electric shock in an escape–avoidance conditioning paradigm. Data were collected from legal documents filed in personal injury lawsuits. Analysis of the findings show that all dogs lacked a marked history of aggressive responding, all were adult males, and most were reproductively intact. All attacks happened near the boundary of the property. In every case, the system was operational at the time of attack. Moreover, in most cases, the dog received shock. Findings lend themselves to possible interpretation in terms of unconditioned aggression as a result of a dog having received electronic shock and avoidance-motivated aggression mediated through fear reduction toward human stimuli.

A nonhuman animal's aggressive reactivity as a result of receiving electric shock is based on an inherent tendency to behave defensively when sudden, sharp pain is experienced (Archer, 1988; Blanchard, Blanchard, & Takahashi, 1978; Moyer, 1976; Rogers, 1981). Pain is believed to be a "primary" stimulus for the release of unconditioned aggressive responding (Scott, 1958). The shock–pain–aggression paradigm has been observed to occur in a surprisingly wide variety of species such as snakes, turtles, chickens, rats, mice, gerbils, hamsters, cats, monkeys, and humans (Heacock, Thurber, & Vale, 1975; Hutchinson, 1973). Moreover, it appears that learning can modify shock-induced aggression. For example, it appears that an ani-

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mal's arousal for aggression (Renfrew, 1997) or the actual response can be conditioned to both social (O'Kelly & Steckle, 1939; Ulrich, 1966; Ulrich, Hutchinson, & Azrin, 1965) and nonsocial stimuli (Hutchinson, Renfrew, & Young, 1971; Lyons & Ozolins, 1970; Vernon & Ulrich, 1966). The response occurs within species, between different species, and toward inanimate objects (Hutchinson, 1973; Ulrich, Wolff, & Azrin, 1964).

Variables that affect whether an animal will respond with aggression after receiving shock include age, sex, and reproductive status (Hutchinson, Ulrich, & Azrin, 1965), and previous social experience (Coleman & Kalberer, 1978). In addition, many studies have examined the effects of shock within the paradigm of escape–avoidance learning. Dogs have been studied in the laboratory using this paradigm, and clearly they readily learn to escape and avoid shock (Brogden, 1969; Brush, 1957; Solomon & Wynne, 1953). Moreover, rats will behave aggressively to terminate shock. Miller (1948) and subsequently others (Azrin, Hutchinson, & Hake, 1967; Dreyer & Church, 1970; Viken & Knutson, 1992) noted this observation of the negative reinforcing properties of shock. Further, squirrel monkeys can be readily conditioned to avoid shock by behaving aggressively (Azrin et al., 1967); when shocked, they will learn to pull a chain to attack an inanimate object (Azrin, Hutchinson, & McLaughlin, 1965). More recently, Tortora (1983) developed a theory incorporating these findings to explain aggressive attack in dogs. Tortora used the term *avoidance-motivated aggression* to explain how previous conditioning affects attack behavior in aversive situations.

Earlier (Polsky, 1994), I provided an overview of the pros and cons of electronic shock collars used as training devices in behavioral modification for dogs. I mentioned the possibility that due to the pain caused by shock, a dog might respond aggressively to a proximate target such as a person or another dog. Independently, other applied animal behaviorists have made a cursory note of the connection between an animal's receiving electronic shock and the elicitation of aggression (Lindsay, 2000; Tortora, 1982, for dogs; Voith, 1986, for horses). Nonetheless, animal care professionals and caregivers (owners) who use shock collars to train dogs might not realize the relation among shock, pain, and aggression. To date, no literature specifically examines this relation in dogs. In this article, I analyze descriptive accounts, which indicate that using an electronic shock collar in a boundary-training regimen was a possible cause of dog attacks on humans.

METHOD

Overview of Electronic Pet Containment Systems

Electronic companion animal containment systems are marketed to dog owners as a safe product for boundary training to keep a dog within or outside a specified area predetermined by the owner. The equipment is available in pet shops,

through mail order, and from the manufacturers or their distributors. An executive from one company estimates that approximately 500,000 of their units were sold in the United States from 1982 to 1997. Many owners find electronic pet containment systems an attractive training option. The systems confine a dog to a particular area, usually a yard, without using conventional fencing. They also can prevent a dog's entry into a specified area such as a flower garden.

Basic Components

Receiver collar. This component, worn around the dog's neck, consists of a radio receiver in a small, lightweight, water-resistant, ultrasonically sealed metal or hard plastic case. The case is fastened to an adjustable buckle strap and placed on the ventral side of the dog's neck. Together, the strap and case constitute a shock collar. Size of the case is approximately 2.5 × 1 × 1 in. Weight is approximately 1.5 oz. Metal prongs protrude from the case, serve as conductors, and apply shock to the dog. For a dog to feel the shock, the prongs must penetrate the fur and make contact with the skin. The collar uses rechargeable nickel cadmium or replaceable batteries (usually 9 V).

Transmitter and transformer. The transmitter sends a coded radio signal to the receiver collar. The transmitter usually is mounted in a plastic container for placement in a weather-protected area such as a garage. The transmitter connects to a transformer that plugs into a 110-V electrical outlet.

Transmitter wire. The wire acts as an antenna for the radio signal produced by the transmitter. Depending on the user's needs, a wire could be as long as several hundred meters and usually is buried underground. One end of the wire connects to the transmitter and then loops around the designated boundary. The other end connects back to the transmitter. For the system to function properly, the wire must remain in an unbroken loop with the transmitter. If it breaks (severed by a lawnmower), the system will not operate. In the United States, as many as 11 companies manufacture electronic pet containment systems for consumer use (Halvorson, 1993).

Details of the electronics in the collars usually are not made available to the consumer. Privileged information made available to me from an independent electrical engineer who examined receiver collars from different manufacturers indicates that the voltage output ranges between 1500 and 4500 V. To account for differences in pain sensitivity between dogs, most manufacturers allow the user to control the intensity of shock through settings in the transmitter. Regardless of the specifics of the electronic parameters, which vary between manufacturers, the sole purpose of the receiver collar is to deliver a painful electrical shock to a dog.

Method of Operation

The collar receives the radio signal produced by the transmitter and shocks the dog. Transmitter settings determine the depth of the signal field. The signal field is the minimal distance between the transmitter wire and the point where the dog must remain to avoid activating the system. Signal fields commonly are 3–10 ft in depth. A dog who enters and stays in the signal field for a specified time, probably 2–5 sec, receives shock through the receiver collar. In addition, the collars emit a tone. The auditory signal, which precedes the onset of shock by several seconds, warns the dog to withdraw from the signal field or receive a shock.

In training, a handler (often the owner) entices the dog with a leash into the signal field where both tone and shock will be experienced. Alternatively, the dog might be allowed to move independently into the signal field. The dog then can terminate the shock by withdrawing, or the handler may prompt the dog to withdraw from the signal field into the yard by intentionally pulling the dog away with the leash. The training manuals supplied to owners suggest that this procedure continue until the dog habitually avoids the signal field.

Electronic pet containment systems are effective because they operate on the established principles of escape and avoidance conditioning. In escape conditioning, a dog withdraws from an area—in this case the signal field— because of painful stimulation. Subsequently, the dog learns to avoid the area due to the negative associations. Handlers try to make the training field as conspicuous as possible to the dog. At the start of training, visual markers such as flags or strings are placed adjacent to the signal field. When the dog enters the signal field, a tone sounds. The dog then may choose to withdraw into the safe area of yard to avoid shock. A dog usually has 2–5 sec to do this. In this manner, most dogs rapidly accomplish avoidance learning.

Data Collection Procedures

I obtained descriptive information from deposition transcripts and other legal documents such as declarations, witness statements, animal control and police reports, and interrogatories made available to me from attorneys representing people who filed lawsuits for personal injury because they were attacked by a dog. In each of five lawsuits from which I collected my data, injury was inflicted on the plaintiff by a dog who had been trained, or was in the process of being trained, to avoid shock with an electronic pet containment system.

Documents were reviewed for information on potentially meaningful variables such as the victim's age and the breed, sex, age, and reproductive status of the dog. Documentation also was reviewed to ascertain the nature and location of the attack (near the boundary, signal field) and the victim's familiarity with the dog. Was the

system operating at the time of the attack, and did the dog receive shock? Did the dog have a history of responding aggressively to humans? Further, did the victim engage the dog in a manner capable of eliciting an aggressive response diagnostically different from either pain-elicited aggression (Beaver, 1999) or aggression based on a dog's anticipation of pain such as avoidance-motivated aggression (Tortora, 1983)?

RESULTS

An account of each incident is provided next. Note that these accounts are based on the descriptions provided by witnesses. As such, they lack the scientific vigor one would expect from an experienced ethological observer.

Case 1

Sawyer was a reproductively intact 2-year-old male golden retriever with no formal obedience training other than what the owner provided. The owner stated that Sawyer was a family dog who had never been aggressive toward any human. Prior to the incident in question, the dog had received some training with the electronic boundary equipment and, in the process, had been shocked on several occasions. The incident happened when a friend of the owner arrived in her car. She stopped her car at the foot of the owner's driveway, which happened to be directly in the signal field. Sawyer was outside and within earshot of the car. The owner's friend lowered her car window and called for Sawyer. The owner, who was nearby, told her friend to stop calling the dog. The owner attempted to call the dog away from the car. However, Sawyer already had reached the car and then, in the words of the owner, immediately started acting as though he was having "convulsions." The owner stated,

> It was already too late because the next thing I remember, he was flying through the air. And then, he starting biting my wrist, and I pulled my wrist up, and he started biting my elbow and the back part of my arm. And the next thing I remember, I was face down crawling in the mud with him biting my side and back. And then about 20 to 30 seconds after that, he was calm and acting as if nothing had happened, just panting over me. And that was it.

Case 2

Moses was a reproductively intact, 3-year-old male golden retriever who had no obedience training prior to the time of the incident. The victim in this incident, the dog's owner, was a middle-aged man. The owner described Moses as docile

and friendly with no previous incidences of aggression toward people. The incident happened during the dog's initial exposure to the system. The owner states that he put the receiver collar on Moses and then led him on leash to the boundary. Immediately after entering the signal field, the dog, in the owner's words, had "a severe reaction." Moses jumped on the owner and attacked him with repeated bites to the arm. He did not bark or growl prior to the attack. The dog latched onto his arm. Shortly thereafter, his wife arrived and was able to get Moses to release his hold. The owner states that he sustained many puncture wounds from the attack.

Case 3

Mac was a 3-year-old reproductively intact male golden retriever. His owner, a middle-aged female, described Mac as a well-mannered dog who was docile with strangers and all family members. Mac was not obedience trained. Prior to the incident in question, the owner reported an isolated incident of aggression toward her and several instances toward a neighbor's male dog. The single incident toward her happened when her daughter accidentally fell on Mac while he was resting. Mac jumped on the owner and momentarily mouthed her arm. The incident did not result in serious injury. Those who knew Mac felt that his reaction was out of character. He always was tolerant of disturbances while resting. Mac reacted noticeably to the shocks he received during his initial exposure to the system. The incident in question happened shortly after the owner had finished walking Mac around the boundaries of her property. She sat down on her lawn with Mac approximately 20 ft from the signal field. At that point, Mac—his leash still attached—got up and approached the boundary. He started to dig near a bush. The owner got up, went after Mac, and told him to stop. She then guided him back with his leash to where she had been sitting. Mac again left the owner and went to a location approximate to where he had been digging. He stopped under a bush and resumed digging. The bush was near the signal field, or it might have been directly in the signal field. Mac was facing away from the owner when she again approached. On reaching him she said, "Come on Mac, we got to go now," and she picked up the leash. She did not tug the leash. The moment she did this, Mac turned his head toward her. Eye contact was made. The owner states that immediately she knew something was wrong: Mac had a strange look in his eyes. She did not hear him vocalize. He then instantly leaped on her and began attacking. In a frenzy-like state, he repeatedly bit her. The attack lasted for at least 30 sec. She attempted to get away by moving backward. Her son arrived on the scene, grabbed the leash, and pulled Mac off. Mac quickly became contrite and, according to the owner, appeared as if nothing had happened. The owner suffered serious punctures on her arms, hands, and back.

Case 4

Obie, a reproductively intact 2-year-old male Akita, was the dog involved in this incident. The owner described Obie as a nonaggressive dog who would alarm-bark in response to strangers' passing the property. Neighbors familiar with Obie said occasionally he would run along the property line when people walked or rode their bikes past. They did not feel that he was dangerous. Obie was not obedience trained. Subsequent to Obie's initial exposure to the system, he appeared to be responding well. Over time, however, he started to violate the system (escaping from the yard). A break in the transmitter wire or dead batteries in the receiver collar apparently caused the violations. He was retrained with higher voltage batteries. The victim in question was a 5-year-old boy. Obie did not know the child.

The incident happened as follows. The boy was walking on the shoulder of the street and came to a stop directly in front of Obie's yard. Obie had just been put in the yard. Shortly thereafter, Obie spotted the boy. Obie was either proximate to the signal field or possibly within the signal field. Witnesses state that Obie left the yard (crossed through the signal field) and made straight for the boy. No growling or barking was heard. Obie went for the boy's head, knocked him down, and then began to shake him. There were numerous puncture wounds on the boy's head, face, and neck. The scalp was torn from his forehead. When the witnesses approached, Obie momentarily stood over the boy and growled. Soon after, Obie's caretaker arrived and removed him without difficulty.

Case 5

Rocky was a reproductively intact 3-year-old male rottweiler. The owners stated that Rocky was nonaggressive and of good temperament, particularly toward children who entered their home. However, one neighbor gave a conflicting statement indicating that Rocky, prior to the incident in question, had displayed aggression toward him on several occasions. No complaints were on record with animal control. Rocky had not been given formal obedience training. Boundary training with the system started when he was a puppy. Except for some isolated violations, the system effectively contained him. The incident in question happened late afternoon in December. Rocky was in the rear of the owner's property. Here he encountered three boys about 8 years of age playing near an abandoned car. The car was positioned adjacent to the signal field on the periphery of the owner's property. According to the children, Rocky, in a nonaggressive state, remained on his property proximate to the signal field.

Because Rocky appeared friendly, two of the boys approached him. Rocky jumped on one of the boys. He knocked the boy to the ground, stood over him, and

started licking him vigorously in the face. This scared the boy. He managed to get back on his feet. All three children jumped on the nearby car for safety. They then decided to run. Rocky pursued the boys. He passed through the signal field. He quickly reached the boys after a short chase. Rocky jumped on one of the boys, knocked him down, and started to nip him. A second boy attempted to intervene and in doing so was attacked in a vicious manner. He was bitten repeatedly on the face and neck. The boy's flesh was torn. Rocky dragged the boy through the snow for a considerable distance. During the time Rocky was dragging him, the boy stated that Rocky continued to bite him. The boy said that at this stage he was exhausted. For his own safety, he decided to play dead. The attack terminated after Rocky's owner started calling him. The owner was alerted by one of the boys who had left the scene to summon help. After hearing the owner's voice, Rocky left the boy and returned to his yard.

TABLE 1
Findings Taken From Legal Documentation

	Cases				
Variables	*1*	*2*	*3*	*4*	*5*
Breed of dog	golden retriever	golden retriever	golden retriever	Akita	rottweiler
Sex	male	male	male	male	male
Age of dog at time of attack	2 years	3 years	3 years	2 years	3 years
Neutered	?	?	no	no	no
Familiar versus unfamiliar person	familiar	familiar	familiar	unfamiliar	unfamiliar
Victim: child or adult	adult	adult	adult	child	child
Prior obedience training	no	no	no	no	no
Prior history of biting a person	no	no	yes	no	no
System operating at time of attack	yes	yes	yes	yes	yes
Dog received shock at time of attack	yes	yes	uncertain	yes	yes
Incident happened near boundary	yes	yes	yes	yes	yes
Dominant action by victim directed to dog	no	no	no	no	yes
Dog threatened victim before attack	no	no	no	no	no
Repeated biting of victim	yes	yes	yes	yes	yes

Note. The 14 variables listed pertain to the dog, the victim, and the electronic pet containment system. Question marks indicate that information was not available.

Table 1 presents a summary of the empirical information gleaned from the descriptive accounts. The most definitive findings show the following facts:

1. All were adult, male dogs. No dog had received formal obedience training. At the time of the incident, three of five dogs were reproductively intact. Information about the reproductive status for the dogs in Case 1 and Case 2 was not available.
2. All of the adult victims knew the dog. On the other hand, children who were victims did not know the dog.
3. No dog had a history of displaying aggression toward people. With the exception of the golden retriever in Case 3, no dog had ever bitten a person prior to the incident in question.
4. In all cases, the system was operating at the time of attack, the incident happened in or near the signal field, and most dogs received shock at the time of attack. In Case 3, it was uncertain whether the attack happened before the golden retriever received shock. At the time of attack, however, this dog was positioned directly in the signal field.
5. In all cases, there was repeated biting of the victim, which resulted in serious bodily injury.

Less conclusive findings show that, immediately prior to the attack, no victim acted in a dominant manner to the dog—petting or hugging the dog, challenging the dog for a coveted resource, or using interactive punishment. Immediately prior to the attack, no dog displayed a warning—bark, snarl, or growl—to the victim.

DISCUSSION

In each case, the incident happened when (a) the dog was wearing the receiver collar, (b) the system was working, and (c) the dog was in or near the signal field. All of these conditions are needed to support the belief that at the time of attack the dog had either received shock or was positioned to anticipate shock due to prior association of shock with proximity to the signal field. Specifically, in Case 1 and Case 2 each dog was physically in the signal field moments before the attack. Therefore, each must have received shock. Based on the sudden and dramatic change in each dog's behavior, clearly this is what happened.

Moreover, in Cases 4 and 5 the dogs passed through the signal field immediately before they attacked. Therefore, these dogs also must have received shock. In Case 3, although the dog was proximate to or possibly within the signal field, it is uncertain whether the dog was shocked. If the dog did not receive shock, then a possible explanation for the attack might be made in terms of avoidance-motivated aggression.

Other criteria suggest that the attacks occurred because of the dogs' exposure to the system. For example, the reaction of each dog was inconsistent with past be-

havior. With the exception of the golden retriever in Case 3, no dog had bitten a human prior to the incident in question. No dog had a marked history of displaying aggression toward people. Albeit subjective and biased, all owners described their dogs as nonaggressive. Others who knew the dogs shared this opinion, except in Case 5, with the rottweiler. These findings allow one to conclude that the primary motivation underlying the attacks might have been different from other common types of aggression such as dominance or territorial or predatory aggression. These latter kinds of aggression usually have developmental histories indicating that a dog has a proclivity for aggression in a specified context (Beaver, 1999). On the contrary, according to owner descriptions, developmental histories for these dogs were absent.

Because developmental histories were probably absent, one would not expect severe attacks. Rather, all dogs attacked with repeated and uninhibited biting. Others also have noted the intense and vicious nature of shock-elicited aggression (O'Kelly & Steckle, 1939; Renfrew, 1997; Ulrich et al., 1964). Further, in all cases—according to witness reports— no gross behavioral warning—bark, growl, or snarl—was given to the victim prior to the attack.

Warnings usually precede attack in displays of dominance and territorial aggression but characteristically are absent in shock-induced aggression. Rather, shock-induced aggression characteristically has rapid onset and lacks species-typical threat displays (Johnson, 1972; Moyer, 1976). Next, according to witness reports, it appears that no victim acted in a manner to elicit a display of dominance from the dog. Recognizable actions—hugging, petting, or grooming—directed to the dog by a person usually precede displays of dominance (Askew, 1996). Finally, the golden retriever in Case 2 reacted aggressively during his very first exposure to shock. This observation is consistent with laboratory findings, which show that previously docile, mature rats will attack each other on the very first presentation of shock (O'Kelly & Steckle, 1939; Ulrich & Craine, 1964).

An alternative explanation that shock caused or facilitated attack rests on the notion of avoidance-motivated aggression (Tortora, 1983). Tortora reasons that fear can become classically conditioned to the stimuli associated with pain and that such conditioning results in the dog engaging in an instrumental response (e.g., attack) directed to the relevant stimuli to reduce fear. This two-process learning theory has been widely used to interpret avoidance learning in animals (McFarland, 1999; Rescorla & Solomon, 1967), including companion dogs (Reid, 2000; Reid & Borchelt, 1996). Because electronic pet containment systems operate on the principles of avoidance conditioning, explanation proffered in these terms seems plausible. Further, one might speculate that conditioned attack happened because shock facilitated a breed- specific tendency such as protection or, possibly, predation aimed at avoiding a potentially aversive stimulus. This interpretation is consistent with findings that show that (a) territorial aggression can be classically conditioned (Hollis, 1990) and (b) squirrel monkeys can be conditioned to attack

when presented with stimuli previously associated with shock (Azrin et al., 1967; Hutchinson, Renfrew, & Young, 1971).

One may surmise further that attack was directed toward humans because of the association between shock and human stimuli. For example, in acquiring an avoidance response, it is likely that a dog learns to associate shock with stimuli other than the tone or flags. This could happen through the Pavlovian process of sensory preconditioning. Brogden (1939) described this phenomenon for dogs. In this regard, modern learning theory states that the kinds of stimuli to become associated are most likely those that are biologically meaningful (McFarland, 1999). In dogs such as Akitas and rottweilers, who are bred for protection, such stimuli could include children moving near the boundary, as in both Case 4 and Case 5. Others have noted that social stimuli can readily connect and serve as a CS for shock (O'Kelly & Steckle, 1939; Ulrich, 1966; Ulrich, Hutchinson, & Azrin, 1965). In short, the behavioral predisposition of certain breeds could make certain dogs susceptible to forming an association between shock and unfamiliar people near the boundary. Some reservations need mentioning in reference to the aforementioned interpretations. First, a professional did not undertake assessment of each dog's behavioral history. The assumption that developmental histories for aggression were absent is based on the biased reports of owners and others who knew the dog. Therefore, it is not certain if a dog lacked behavioral problems.

Likewise, details of both the victim's and the dog's behavior immediately prior to attack are based on the victim's version of the incident and on the naive observational skills of witnesses. Some of the dogs could have displayed subtle aggressive signals such as stiffening of body, change in ear and tail position, and dilation of pupils that would have been missed unless the witness was watching specifically for them. Because information like this may not be reliable, it allows for interpretation of attack along lines that are different from conditioned attack or shock-elicited attack.

In addition, there was indication that both the golden retriever in Case 3 and the rottweiler in Case 5 had displayed transitory bouts of aggression prior to the incidents in question. A neighbor testified that the rottweiler growled at him on several occasions. The golden retriever's owner states that her daughter tripped over the dog, causing him to startle and momentarily mouth her arm (possibly a dominance display). These findings therefore suggest an alternative explanation in terms of dominance aggression or territorial aggression. Consistent with this interpretation is the finding that many behavioral problems in dogs make their first appearance in the 2- to 3-year age range (Beaver, 1999). Note that all dogs in this study were approximately this old (see Table 1). In the absence of more thorough and accurate behavioral histories on each dog, the small sample size, and the specifics of the dog's behavior at the time of attack, the implication that shock was associated with, or the cause of, the dog's attack remains tenuous. The nature of the data, gleaned from documentation in lawsuits, makes it difficult to rule out alternative

explanations for attack behavior such as dominance aggression, territorial aggression, or predatory behavior.

Accurate data on the number of dogs who become aggressive might be difficult to obtain without full disclosure from the manufacturers and the ability of owners to recognize the possible causal link or association between aggression and the use of these containment systems. Manufacturers stress that their systems are safe, ethically acceptable, and that they work successfully for the vast majority of dogs. Despite these claims, manufacturers need to acknowledge the risks involved and make consumers aware that the systems are not foolproof and that some dogs could attack a person as a result of having received electric shock.

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