Electronic Training Devices: A Review of Current Literature

Jo Jacques, CPDT, CPCT and Sandy Myers, CDBC

This research is divided into four main areas:

1. Electronic training devices and how they work
2. Physiological effects
3. Psychological effects
4. Effects on learning

A Summary is included at the conclusion of this article, along with explanations of electrical terms (Appendix A) and Internet resources (Appendix B).

Introduction

The use of electronic devices to train animals is a controversial issue that elicits strong emotions. This literature review summarizes currently available scientific research concerning the effects of electronic training devices and related issues. The role of a literature review is to find and present pertinent work from peer-reviewed journals that publish original research findings. The literature is then presented in a logical, organized manner. Every effort was made to give a synopsis of the research without personal opinion or conjecture.

Electronic Training Devices and How They Work

"Remote collar," "electronic collar," and "shock collar" are terms used to describe electronic training devices. Common variables of all of these devices include the level of shock or stimulation, the quality of the equipment, and the person with the control device. In *Handbook of Applied Dog Behavior and Training: Procedures and Protocols, Vol. 3* (2005), Lindsay explains in detail the electrical engineering that goes into these collars (pp. 570-573). There is no evidence of standardization for electronic training devices, and the quality varies from one manufacturer to the next. Some manufacturers have developed collars that have a wide range of settings and the ability to administer various levels of electricity. High-quality collars consistently produce a less unpleasant sensation when they are on a low to medium setting.

In the simplest terms, electrical stimulation can be categorized by levels: low, medium, and high. Low-level electrical stimulation creates a tickle and tingle effect, mid-level electrical stimulation enables the handler to annoy or startle, and high-level electrical stimulation is believed to produce significant pain and distress in dogs (Lindsay, 2005, pp. 575-577). It would be far too difficult within this article to discuss each and every possible level of electrical stimulation; therefore, these three categories will be used exclusively throughout this paper. The experimental studies cited below used electrical stimulation at various levels.

In experiments that applied shock to the feet, Lessac and Solomon (1969) determined that leg flexion required around 0.08 mA electric intensity and elicited a yelp response at 2.80 mA (1969). Merriam-Webster's Online Dictionary defines flexion as a bending movement around a joint or limb (www.merriamwebster.com, accessed January 28, 2007). In a similar study, Brush determined that avoidance learning increased with shocks up to 4.8 mA, with the desire to escape appearing above 5.0 mA intensity (1957).

To understand the physical effect of a shock collar, it is necessary to look at the closed-circuit values. Pulse duration and pulse repletion rate are very important factors in determining the collar's adverse effects. In 1991, Kaczmarek wrote that the collar will be more aversive when the electrical pulse is longer and the repetitions are more rapid. Current passed through narrow electrodes, as used in e-collars, causes significantly less discomfort than the same current passed through wider diameter electrodes (Lindsay, 2005, p. 775).

The length of coat, hydration of the dog, how the dog holds his head, and amount of dirt and debris on the dog are also factors in the amount of electronic stimulation/shock the dog receives. Other factors that affect the degree of stimulation include the size and type of electrodes (as noted above), distance between electrodes, voltage and amperage levels, as well as the impedance of the tissue at the sites of contact with the electrodes. Impedance is defined as how much resistance the electricity encounters to complete a circuit, or electric charge (http://unabridged.merriam-webster.com, accessed 28 July, 2006). The greater the tissue impedance, the less electrical conductivity is seen; conversely, less tissue impedance results in greater electrical conductivity. Tissue impedance is affected not only by the location of the electrodes, but by the amount of connective tissues and fat deposits, as well (Ahn, Wu, Badger, Hammerschlag, & Langevin, 2005; Tagliabue, et al., 2001).

Physiological Effects

To determine whether electronic training devices cause physical stress, it is necessary to look at the animal's physiological reaction to these training devices. By looking at scientific data, we are better able to make an educational assessment. There are several studies cited below that enable us to observe documented changes in heart rate and cortisol levels when electric shock is being used. For the purposes of the following discussion, "stress" is defined as "a physiologic condition in response to environmental or psychological pressures. These pressures are referred to as stressors. This condition is accompanied by, but not limited to, elevation in corticosteroid levels and may be accompanied by concurrent behavioral changes" (Marder & Voith, 1991).

Behavioral, saliva cortisol, and heart rate responses to different types of stimuli in dogs (Beerda, B. (1998). *Applied Animal Behaviour Science,* 58, 365-381).

The goal of this study was to establish parameters for determining stress elicited by different stimuli in dogs. Guidelines for physiological levels indicating stress were determined from previous studies, one of which showed that when a dog was exposed to noise, heart rate and cortisol levels increased at 30 seconds and returned to normal at 4 minutes (Engeland, 1990).

The dogs in the Beerda study were exposed to a loud noise, electric shock (estimated to be medium level electrical stimulation, or MLES), a bag dropped from the ceiling, physical restraint, and an umbrella opening. Body posture, saliva cortisol levels, heart rate, and behavior responses were analyzed. The average heart rate for dogs in the study was 75 BPM (beats per minute). Heart rate following the presentation of stimuli increased to an average of 160 BPM. The base saliva cortisol level for dogs in the study was 6.0nmol/1. Saliva cortisol levels, on average, increased to 13nmol/1 following the presentation of stimuli.

The results of this study showed that the greatest increase in cortisol levels occurred when dogs were exposed to loud noise, a bag dropped from the ceiling, and electric shock. The time necessary to return to the baseline heart rate was longer when the dogs were exposed to the loud noise and the bag. Heart rates were not measured when the dogs were exposed to electric shock (monitors were removed to guard against equipment damage from electrical currents). This study reported behavioral responses of very low body posture to the dropped bags, loud sounds, and shock, while the restraint and umbrella responses included restlessness, defined as high levels of body shaking and verbal behaviors (social communication). The authors of the study were quite clear in stating that while the stress responses to the bag, sound, and shock were distinctly higher than to the restraint and umbrella stimuli, the fact that a human was present in the restraint and umbrella tests enabled the dog to anticipate the stimuli before they occurred.

This study is a good example of signs of stress, positive as well as negative associations to humans, and the increase of stress when electric shock is used in unpredictable situations. Several studies have noted a change in the physiological effect on the dog when in the presence of a person. It is important to understand these effects when looking at physiological reactions to electronic training devices, because a human is often a component in the equation.

Note: We personally believe that while this study was a good example of using cortisol to measure stress, that was the only hormone measured. However, other studies have shown that cortisol is not the only hormone affected under stressful conditions. In fact, since cortisol level is used as a determinant when diagnosing various adrenal autoimmune disorders, we're left wondering if the levels obtained may have been influenced by other conditions.

The effects of petting on classically conditioned emotional response (Lynch, J.J. & McCarthy, J.F. (1996). *Behavior Research and Therapy,* 5(1), 55-62).

In this study, the authors observed the physiological effects of human contact on the dog. The research found that the dogs' heart rate increased when a tone was followed by an electric shock of a medium level. The electric shocking device used was a high-voltage system, one-second shock, different for each dog according to the dog's reaction at each interval. The level of shock used was intense enough to cause the dog to fully flex his leg off the table.

Heart rate was measured during a 10-second tone-shock sequence (conditioned reinforcer, or CR) for three separate conditions: dog alone; person present but no physical contact; and person petting the dog. The initial results showed that when the dog was alone, the tone (CS) caused the dog to anticipate the shock, resulting in an increased heart rate from 82 BPM to 150 BPM (9 seconds prior to the shock). When the person was in the room but not making contact, the dog's heart rate initially decreased to 80 BPM right after the tone, but rose to 150 BPM just before the shock was administered. The last sequence consisted of a person petting the dog during the tone-shock sequence; the dog's heart rate was recorded at approximately 70 BPM during the tone phase. (The normal rate for a dog is approximately 70 BPM.)

Initially, the presence of a person decreased the dog's heart rate. However, the authors found that after two or three days the heart rate decrease was extinguished when a person was present. A conclusion can therefore be drawn that the physiological reaction of the dog to the presence of the human initially lowered stress. However, the authors concluded that, over time, the value of the human as a de-stressor was extinguished.

Are we dog's best friend? Predicting canine cortisol response from human affiliative and punitive behaviors (Jones, A.C. & Josephs, R.A. *Current Issues and Research in Veterinary Behavioral Medicine 2005 – Papers Presented at the 5th International Veterinary Behavior Meeting,* West Lafayette, IN: Purdue University Press:194-197.)

The goal of this study was to determine the physiological influence human behavior has on dogs. 184 dogs participated in the study, and cortisol levels were measured before and after an agility competition. The results of this research showed that play and petting decreased cortisol levels, while punitive behavior (yelling and physical non-play) on the owners' part increased cortisol levels.

"Affiliating (play, tug of war, chase) behaviours are associated with a lesser increase in dog's cortisol levels (beta weight= -0.131); punitive behaviours (yelling, physical pushing) are associated with greater increase in dogs' cortisol levels (beta weight = 0.119)," the authors stated. In their conclusion, the authors also said that dogs who frequently had elevated cortisol levels may suffer from illness, including cognition degradation and physical problems that could shorten their lives.

Clinical Signs caused by the use of electronic training collars on dogs (*Canis familiaris*) in everyday life situations. (Schalke E, Stichnoth J, & Jones-Baade R. *Journal of Applied Animal Behavior Science*, doi:10.1016/j.japplanim.2006.11.002.)

The purpose of this study was to determine whether any stress is caused by the use of electric shock collars or not, and in this way contribute to their evaluation with respect to animal welfare. Baseline heart rates and cortisol levels were measured, in addition to measurements taken at various stages of the study, and their training as well as the experiments themselves were carried out in a building, in order to remove the influence of external stressors. In addition,each dog was allocated an individual time slot for training, in order to exclude circadian deviations. Electronic collars were used to train all of the dogs. The collars were the Teletakt micro 3000 (ohm levels of 500 to 2.2 kohm). All dogs were trained for three months by the same trainer to successfully hunt (that is, chase) a dummy rabbit. The dogs were then divided into three study groups. Group A (Aversive) was trained to avoid prey by receiving a shock at the precise moment they touched the dummy rabbit, forming an association between touching the prey and shock. Group H (Here) received additional training to come on command, and were then tested in a situation where they were asked to avoid prey with a "here" command. If they did not respond to the "here" cue, they received a shock. Group R (Random) was given a random electric shock prior to attention toward prey, while hunting, or after the hunting sequence when the prey had been removed. The timing of the shock was decided by drawing lots.

Prior to any testing, a baseline cortisol level was established for each dog. Preliminary levels were taken when the dogs participated in two tests (on different days), "Simple hunting" and "hunting impeded." "Simple hunting" was when the dogs were allowed to hunt with no restrictions. "Hunting impeded" was when the dogs were restricted from hunting by using a leash. Beginning ten minutes after the end of the hunting sequence, five saliva samples were taken every five minutes. Once divided into the three groups, the main experiment was conducted. During the main testing phase, electric pulses were given according to the group each dog was in. Each dog was allowed a maximum of only one shock per day; and heart rates were continuously monitored. Cortisol levels were tested in 5 minute intervals, beginning 10 minutes after the application of shock. Post-testing was also performed: during the 4 weeks following the main test, the dogs had no contact with either the environment or the persons conducting the test. At the end of that time, they were taken back to the experimental environment, and cortisol and heart rates were measured (without additional testing).

The dogs in Group R (who received random shock) showed the highest cortisol level of all three groups, leading the researchers to hypothesize that cortisol increased in this group because the dogs had no chance to associate their behavior or a warning signal (the cue "here") with the punishing stimulus. Group A, the group that received aversive training in association with prey, had the smallest increase in cortisol levels. Significant differences were also found when comparing heart rate values between the three groups. As with recorded cortisol levels, heart rates were highest with Groups R and H, and lowest with Group A.

Comparisons were then made between the preliminary, main, and post-testing phases. Within Group A (Aversive), cortisol levels were significantly higher during testing than during preliminary or post testing. In Group H (Here), cortisol levels during post-testing were significantly higher than the values recorded during testing.

Concerning Group R (Random), however, the levels measured during post-testing were higher than those gathered during the preliminary testing as well as the main testing phases. The researchers feel this result corresponds with Polsky's (1994) statements that poor timing and/or shock that lasts too long causes a fear of the environment and/or people in dogs.

The ability of the dogs to predict an outcome did affect the level of cortisol increases seen. Those dogs who had been trained to see prey and avoid it had learned how to avoid the electrical stimulation. Those dogs who understood "here" but had not learned to respond when prey was present had increased stress and cortisol when electrical stimulation was given, and those dogs in the last group could not avoid the electrical stimulation because they had no predictor of its cause.

The researchers state, "This study indicates that the general use of electronic shock collars is not consistent with animal welfare. It has to be assumed that pet owners do not have the sufficient knowledge about training and skill to avoid the risk that dogs will show severe and persistent stress symptoms." They further conclude, "The results of this study suggest that poor timing in application of high electric pulses, such as those used in this study, means there is a high risk that dogs will show severe and persistent stress symptoms. We recommend that the use of these devices should be restricted with proof of theoretical and practical qualification required, and then the use of these devices should only be allowed in strictly specified situations."

Fear conditioning occludes LTP-induced presynaptic enhancement of synaptic transmission in the cortical pathway to the lateral amygdala (Tsevtkov, E., Carlezon, W., Benes, F., Kandel, E., & Bolshakov, V. (2002) *Neuron,* 34*(2),* 289-300).

This study attempted to prove a longstanding theory that learning takes place and memories are formed when the same message travels repeatedly between specific cells in the brain. During the study, researchers introduced rats to a sound that was accompanied by an electric shock to the foot. The shock, while of a low intensity, did cause the rats to be visibly startled. The day after the rats were trained this way, they were exposed to the sound but were not shocked. However, the sound still frightened them, even more so than during the initial training, and their fear increased as time passed.

To determine that there was a physical change, the researchers used the sound to stimulate rats who had not been trained with electric shock and found there was a flood of nerve impulses between specific cells in the amygdala. In the trained rats, however, there was no flood of communication between the cells, showing that the cells had not only retained the training, but had been physically changed by the experience. The brain change wasn't temporary—it lasted for the rest of the rat's lives (two to three years).

These results indicated that the pathways to the amygdala are modified during the acquisition of a fear response. The researchers also concluded that the physiological changes occurring during emotional learning contribute to intense anxiety disorders, including post-traumatic stress disorder (PTSD), and are what makes these fears so resistant to extinction.

Biobehavioral monitoring and electronic control of behavior (Lindsay, S. (2005). *Handbook of Applied Dog Behavior and Training: Procedures and Protocols*, *Vol. 3*. Iowa: Blackwell Publishing, 557-665.)

In his recent book, Steven Lindsay cites many research studies concerning electronic training devices. In the chapter,"Biobehavioral Monitoring and Electronic Control of Behavior," he states that electric shock at high levels can cause distress and emotional harm to dogs (p. 576). With all the factors and electrical contingencies, the best way to understand the level of electrical stimulation is to feel it. Contact with electricity causes the body to respond as if injured (at low levels there is no physical damage)—the brain perceives a threat to survival that causes neurological, psychological (fear of pain), and physiological responses (heart rate and cortisol levels increase).

High-level electric shock (HLES) causes a neurological response and a perception of pain, and activates muscular and skin-burning sensations even if there is no physically burned flesh and although no physical damage has actually occurred. The study specifically stated that the sensation of burning was perceived even when there was no actual physical injury (Sang et.al., 2003). Medium-level electric shock (MLES) produces sharp pricking, jabbing sensations. Low-level electric shock (LLES) causes tapping, tickling, and/or tingling sensations. According to Lindsay, it is important to remember that high voltage does not mean a higher level of shock; other variables contribute to the perception of pain, such as ohms, impedance, and the individual dog's tolerance, temperament, and relative sensitivity to aversive stimuli.

While many researchers have cited cortisol levels as an indicator of stress, Lindsay reports that King, et al., (2003) have suggested that heart rate might be a more practical and sensitive measure of a dog's reaction to novelty and fear. Other researchers in the field have found that a reactive pattern of cardiac acceleration and deceleration in response to social and environmental stressors seems to correlate with an increased vulnerability to reactive social behavior and susceptibility to stress (Vincent & Mitchell, 1996; Vincent & Leahy, 1997). Blood pressure and heart rate changes appear to be highly sensitive to traumatic events, and these conditioned cardiovascular changes may persist or worsen long after the escape/avoidance behavior has ceased (Dykman & Gant, 1997). Dogs affected by this social anxiety may exhibit signs of persistent anxiety or arousal, as well as hypervigilance and readiness for defensive autoprotective behavior. These changes are correlated with heart rate, heart-rate variability (HRV), and other indicators of autonomic activation. (HRV is the beat-to-beat changes in heart-rate rhythm that occur in response to anxiety and excitement.)

Lindsay also cites research concerning the physiological effect of stress (pp. 562, 579-580). A study by Beerda, et al., (1998, cited earlier in this paper) reported a nonspecific increase in heart rate in response to both social and non-social stressors, concluding, "Heart rate increases should best be regarded as general responses to possibly meaningful events, irrespective of whether these are appreciated as positive or negative." Although these researchers could not demonstrate the existence of discriminative heart rate changes in response to acute social and nonsocial stressors, they did show differences in HPA (hypothalamic/pituitary/adrenal) activity of dogs exposed to nonsocial stressors (e.g., loud sound, electric shocks, and a falling bag) versus dogs exposed to a social restraint (holding the dog down) and startle delivered by a social object (opening an umbrella in the dog's direction). The HPA system is brought into play during times of biological and physiological stress, and stimulates the release of cortisol into the bloodstream. Dogs who could control the occurrence of shock by escaping had significantly less cortisol response than dogs who where unable to escape a shock (Dess, et al., 1983).

Lindsay reports on a study done by Anderson and Brady (1971) that found that dogs exhibit a significant and stable reduction in heart rate and an increase in blood pressure during a one-hour waiting period immediately preceding a two-hour period of shock-avoidance training. The dogs were conditioned to a particular schedule of shock training. The divergence between heart rate and blood pressure steadily increased over the course of the waiting period, with heart rates becoming lowest and blood pressure becoming highest just before the onset of shock-avoidance training.

Psychological Effects

At issue is the question, "Do electronic training devices elicit psychological responses?" This section cites several research studies in which the psychological impact of the use of electronic training devices was analyzed. It is difficult, at best, for anyone to determine the full psychological effect of these devices or training methods until we can agree on exactly what constitutes a stress signal in a domestic dog. Not only do none of the researchers agree on what it is, but it varies from dog to dog. It is even more difficult for humans to determine the full effect of shock on a dog (or any animal) due to the animal's hard-wired need to hide pain in order to survive in the wild.

Training dogs with the help of the shock collar: Short and long term behavioral effects. (Schilder, M. & van der Borga, J. (2004). *Applied Animal Behavior Science,* 85, 319-334).

The goal of this study was to determine the behavioral changes in dogs during training using electronic training collars. Thirty-two dogs were divided into two groups, each receiving both general obedience and protection training. One group was trained with shock collars and the other group without shock collars. The dogs trained with the shock collars displayed signs of stress: lowering of body posture, high-pitched yelps, barks and squeals, avoidance, redirected aggression, and tongue flicking. It was also noted by the authors that, even during play and relaxed walking, the group of dogs trained with shock collars continued to show signs of stress while in the company of their handler.

The authors concluded that shock-collar training is stressful; receiving shocks is a painful experience to dogs; and the shock group of dogs evidently learned that the presence of their owner (or his commands) announced the reception of shocks, even outside of the normal training context. They suggest that the welfare of these shocked dogs is at stake, at least in the presence of their owners.

This study has come under considerable fire because the experience of the handlers and dogs is not clear, and the level of shock is not stated. With that said, it does suggest that dogs are stressed by the experience of being shocked during training.

In rats, sighs correlate with relief (Soltysik, S. & Jelen, P. (2005). *Psychology and Behavior.* 85, 598-602).

This study was designed to discover if a deep breath (i.e., a sigh) in mammals, which functions to prevent airlessness in hypoventilated parts of the lungs, can also signify relaxation or relief. Sighs can be associated with emotions in humans, and, in addition to their respiratory functions, there may also be a selective facilitation of sighs in animals to indicate fear, anxiety, or relief.

To induce fear, a "danger" stimulus (a light or a tone) was paired with an electric shock applied to the tails of rats five times in a daily session. To provide a relief signal, another stimulus signifying "safety" (a tone or a light), presented before the normally expected shock, was followed by the omission of the shock. In 16 rats experiencing a shock during the danger stimulus and a relief during the safety stimulus, the rate of sighing was 7.5 times higher during relief and 20 times higher between trials. This serves to support the hypothesis that sighs in social animals may function as a signal of relief.

Effects on Learning

Electronic training devices result in aversive conditioning, once the link is made between the behavior and the aversive stimuli (electric shock). Aversive stimuli, by definition, cause discomfort, pain, or an otherwise negative experience. It has been shown that while aversive conditioning can take place rapidly and can influence the suppression of unwanted behavior, this suppression is restricted to the presence of the conditioned stimulus after full conditioning has taken place (Seligman and Johnston, 1968). As well, while aversive conditioning may eliminate an unwanted behavior, it does not serve to establish an acceptable alternative. This is most likely due to response blocking—the dog learns that not responding leads to the absence of the aversive stimuli, and stops responding (Seligman and Johnston, 1968).

Can aggression be elicited through electronic pet containment systems? (Polsky, R.H. (2000). *Journal Applied Animal Welfare Science, 3*, 345-357).

The author surmises that the use of electronic containment systems can cause dogs to attack humans. Five cases involving severe attacks to humans by dogs kept in with electronic containment systems were analyzed. The information about these cases was derived from legal documents. An electrical engineer who examined several receiver collars from different manufacturers reported outputs of 1,500 to 4,500 volts, but no reported levels for mA were given. In all cases, the dogs did not have a history of any type of aggression before the use of an electronic containment system. They were all adult males, had received little obedience training, and most were not neutered.

The attacks happened on or near the boundary and the fence system was working in every case. Of the victims, all adults were known to the dog, all children were not known. In all cases, the dog was positioned directly within the signal field, and therefore must have received a shock. In all but one case, no "dominant-appearing" or threatening action was performed by the victim toward the dog. In all cases, the dogs gave no warning prior to the attack, and there was repeated biting of all victims, resulting in serious injuries to head, face, back, and neck.

The author believes the analyzed cases suggest that these dogs became aggressive because of the electronic containment system. What is not known is the type of training the dog received when introduced to the containment system, if the dogs spent a lot of time outside unsupervised, and at what shock level the collars were set. In all cases, the victims were in or near the signal field and each received several serious bites. According to the author, one factor that suggested the attacks occurred because of the dog's exposure to the system was that the reaction of all dogs was inconsistent with past behavior. Only one dog had ever bitten a human, and no dog had a marked history of displaying aggression toward humans. As well, since there were no developmental behavioral histories of these dogs, one would not expect attacks of such severity.

Nonlethal techniques for managing predation: Primary and secondary repellents (Shivik, J.A., Treves, A. & Callahan, P. (2003). *Conservation Biology*, *17*(6), 1531-1537).

The purpose of this study was to develop techniques to decrease the conflicts between humans and wolves when the wolves are seeking prey (cattle, sheep, and dogs) by discouraging wolves from eating prey left in certain areas. The researchers presented freshly killed carcasses to groups of wild wolves in specifically demarcated pens. They tested primary repellents (flags, and a behavior-contingent light and sound device) and secondary repellents (shock collars that were proximity-activated, using buried perimeter wires) to determine which were most effective in deterring wolves from eating the killed prey. The researchers calculated the amount of food consumed prior to, during, and after the testing to determine the efficacy of each type of repellent.

The wolves in the group inhibited using shock collars had various reactions: running away, yelping, or appearing mildly annoyed but continuing to consume the carcass. In post-treatment trials the wolves in all of the test groups consumed all food and none of the aversive methods had any long-term effect on predation. The level of shock was not disclosed; however, it was noted that an electronic containment system was used to establish the point at which the aversive stimuli would be administered.

This study demonstrates the use of aversive techniques in a situation unlinked to the presence of humans. It also shows how wolves can misinterpret intended links between the stimuli and shock/pain and/or discomfort. The authors noted that aversive stimuli could be difficult to apply, as wolves may not associate the pain with the presence of prey, but with another environmental cue.

Behavioral changes and aversive conditioning in hunting dogs by the second-year confrontation with domestic sheep (Christiansen, F.O., Bakken, M., & Braastad, B., (2001A). *Applied Animal Behaviour Science, 72*, 131-143).

The authors of this study were trying to determine the effectiveness of electronic training devices, as well as observe any long-term effects the use of these devices might have. This study was conducted over a two-year period and involved 114 dogs. Three hunting breeds participated in the test: Norwegian Elkhounds, English Setters, and hare hunting dogs. To determine baseline behaviors, each dog was given a "path test." During the path test, each dog was exposed to novel and startling stimuli while being walked on leash by the owner. At this point in the test, each dog was exposed to a sheep tied five meters away from the dog.

The second test was the "sheep confrontation" test. During this test, each dog wore an electronic training collar, and for safety reasons, had a long line attached to his collar. Each dog was released into a sheep pen with a herd of sheep, and if the dog approached within one to two meters of the sheep, the collar was activated (a one-second shock at 3000V and 0.4 A). Shocks were administered only if the dog approached the one to two meter distance. Observational data was collected in both tests, as well as in a questionnaire in which the owner was asked about their dog's previous experience with sheep, living environment, response to gunshots, and aggressiveness toward humans and dogs.

After a year had passed, the tests were repeated. The owners were asked if they noticed any changes in behavior, interest in sheep, and increase/decrease in aggression toward humans or dogs. 88 of the dogs in the study were reported by their owners to have no changes in behavior from the first to second year; 18 of the dogs showed less interest in sheep (one of these had received a shock the first year and 17 had not received any shock**).** The owners' observations were an important element in this study. The level of knowledge and/or expertise of these owners is unknown and is therefore subject to conjecture.

Second-year testing results showed that dogs who had received a shock the first year responded or moved away much sooner from the novel stimuli or sheep than they had the previous year. The second-year tests also showed a decreased number of shocks given to the dogs who had received a shock(s) the first year. Age, breed, and previous experiences did affect each dog's reaction to the sheep from one year to the next: The younger the dog, the less bold his approach toward the sheep the first year. One year later, those same dogs seemed more confident and willing to approach. The authors hypothesized that "dogs could not reliably be tested toward sheep before they are two to three years of age."

As with several of the other research studies reviewed in this paper, each dog is different in his tolerance and sensitivity to electrical stimulation. The authors did reference the difference in retained learning between coyotes and dogs. The dogs did learn to inhibit their approach of sheep from one year to the next, while the inhibition effect for coyotes persists approximately four months (Andelt et al., 1999).

Dog training methods: Their use, effectiveness, and interaction with behaviour and welfare (Hilby, E.F., Rooney, N.J., & Bradshaw, J.W.S. (2004). *Animal Welfare*, *13*, 63-69).

This study was designed to examine the relative effectiveness of different training methods and their effects on a pet dog's behavior. The study results came from evaluating a questionnaire distributed to and answered by 364 dog owners in the U.K., and was based on how basic tasks (give/leave an object, heel, sit, down, come, house-training, stealing, chewing) were trained. The methods reported included punishing the dogs to eliminate behaviors (hitting, jerking the leash, yelling, etc.) and rewarding the dog for desired behaviors (using play, praise, and food rewards). Of the respondents, 20.2% used rewards only; 9.8% used punishment only; 9.6% used miscellaneous (i.e., redirection) or no methods; and 60.4% used a combination of rewards and punishment.

The results show that in four specific areas—house-training, the recall, stealing, and sit—there was no significant difference in the level of obedience obtained (shown by percentage of proper behavior shown) among the methods used to train. However, for the rest of the tasks, the training method that used rewards only achieved a significantly higher rate of obedience than other methods. Similarly, using rewards only greatly reduced the incidence of problematic behaviors, including aggression toward people and other dogs, fear, repetitive behaviors, over-excitement, anxiety, and separation issues.

The results suggest that the use of punishment seemed to be linked to an increase in the occurrence of the problematic behaviors listed above. The number of times owners reported using punishment-based methods correlated positively with the number of problem behaviors seen. While it may be that punishment increased the number of problem behaviors, it's also possible that the owners of dogs already exhibiting problem behaviors are more likely to use punishment when training. Nonetheless, the authors of this study believe that for the general dog-owning public, using rewards exclusively in training may produce a more balanced and obedient dog, thereby reducing the number of owner-relinquished dogs in shelters.

This study has come under fire due to the method used for collecting the data. As stated above, the results were obtained by tabulating responses from questionnaires filled out by dog owners and distributed by veterinarians working with the owners involved in the research project in order to obtain a 'relative' effectiveness score. This kind of self-reporting is not objective. A high percentage of owners reported that, while their dogs showed behavior issues that they themselves did not regard as a problem, others experiencing the same issues might. This could suggest that owners who use punishment-based training may be more likely to view their dog's behavior in a negative light, while owners using reward-based training may be more likely to view their dog's behavior in a positive light. However, since the study examines the efficacy of training as determined by the owners of these pet dogs, it bears re-examination as owner perception is one of the strongest indicators of pet retention.

Differential diagnosis and management of human-directed aggression in dogs (Reisner, I.R. (2003). *The Veterinary Clinic Small Animal Practice*. *33*, 303-320).

This paper was written to give insight into human-directed aggression. The author cites many studies that show contributing factors and reasons why dogs act aggressively toward humans (Guy, Luescher, Dohoo, et al. 2001B; Borshelt, 1983; Moyer, 1968; Overall, 1997; Beerda, Schindler, vanHooff, et al., 1999). Many aggressive behaviors are triggered by anxiety. Highly sensitive dogs have a greater risk of displaying anxiety-related behaviors: exaggerated watchfulness, reactivity to a perceived threat, and the inability to perform normal avoid or escape behaviors. Breeds that are highly sensitive include, but are not limited to, Border Collies, German Shepherd Dogs, and Australian Shepherds. It is also interesting to note that these are breeds that are known for their high level of intelligence and trainability. A repeated point of this paper is the importance of establishing the sensitivity, or level of anxiety of an individual dog and avoiding aversive training methods, which the author feels has been shown, historically, to increase aggressive or anxiety-related responses.

Public health authorities report that the most severe dog attacks were committed by dogs left alone outside for long periods of time (Gershman, 1993). The lack of supervision and environmental control increases the potential for aggressive behaviors to occur. Therefore, the author recommends that owners do not rely on underground electronic fencing for containment; if the dog must be housed outdoors, he should be enclosed in a secure chain-link run or within a secure, visible fence.

The author also advises that, in order to reduce aggression, all circumstances, provocations, and aversive interactions associated with the dog's aggression need to be avoided. Many aggressive dogs are anxious or fearful, and punishment of any kind should be avoided. The author states, "Aversive tools such as electric stimulation (shock), prong, or training (choke) collars that require pulling and jerking to work, hitting and scolding can increase anxiety and therefore increase the risk of biting; in addition, they are likely to lead to treatment failure"

Biobehavioral monitoring and electronic control of behavior. (Lindsay, S. (2005). *Handbook of Applied Dog Behavior and Training, Vol. 3: Procedures and Protocols,* Iowa: Blackwell Publishing, 557-665).

In his *Handbook of Applied Dog Behavior and Training, Vol. 3: Procedures and Protocol*, in the chapter "Biobehavioral Monitoring and Electronic Control of Behavior," Lindsay recounts several studies that show dogs exposed to inescapable shock, increased levels of shock, and unpredictable shock demonstrated impaired ability to escape (learned helplessness) (Houser and Pare, 1974; Seligman and Maier, 1967; Seligman et al., 1968). In the section on "Electronic Containment Systems," Lindsay states that dogs who are inappropriately exposed to an invisible fencing system using electric shock collar may subsequently show intense fear and avoidance of the yard.

Lindsay adds that the first experience of some dogs to being walked on leash by a stranger is when they experience intense electrical shock by a containment-system salesperson or installer. As a result, dogs may show generalized anxiety or reactivity when on leash, as well as wariness or auto-protective behavior toward strangers encountered near the fence boundaries. The resulting social fear response toward the unfamiliar persons may be highly durable and resistant to extinction and counter-conditioning efforts. A shock that occurs during play or in proximity to children can cause a loss of trust and security and may compromise a dog's ability to feel safe or to relax when in similar situations (Polsky, 1998; 2000).

These findings seem to correlate with the brain changes seen in the amygdala during the acquisition of fear, including the duration and increasing intensity of the expression of these fears (Bolshakov et al., 2002). These correlations suggest that while electronic avoidance training may be useful in certain situations, such as livestock and predatory problems (Christiansen, et al, 2001A, 2001B), they may not be the best choice for the average pet owner, who may be unable to deal with increasing fear responses for the duration of the dog's life (Polsky, 1998; 2000).

Summary

In reviewing many research studies, a common thread was repeated: electronic training devices are aversive. Electronic training devices should not be used as the first level of training, and when used, should be used only by skilled and experienced handlers. Currently, little scientific research has been published concerning the practical use of electronic training devices for companion animals. The research studies that have been included in this paper are a compilation of those studies currently available. A very important component when discussing the use of these electronic devices is the human factor involved—reliability when using aversives may be a focus for a future article, as well as laws governing the use of electronic, citronella or bark-activated collars, and ultrasonic devices.

There have been hundreds of studies concerning the effects of electronic stimulation/shock in multiple settings, including clinical use. To date, electronic stimulation has become the most studied form of aversive stimulus that dog trainers use, though most studies involving dogs have discernable methodological weaknesses. Studies show that when used correctly by a skilled trainer, no physical injury should occur. As with most tools, the handler's ability can help determine the effect of the aversive; however, each dog is an individual and the response to aversive stimuli will be different for each dog. A low-level electrical stimulus for one dog can be entirely different for another. It may be difficult for a novice to determine exactly what effect the collar is having on a dog if they are not aware of the subtleties of canine communication signals.

However, can the majority of dog owners be counted on to deliver shocks reliably? Studies, such as those by Schalke, et.al., seem to illustrate the possible outcome of poor timing and/or excessive use. In the conclusion of his chapter "Biobehavioral Monitoring and Electronic Control of Behavior," Lindsay's opinion is that average dog owners typically lack the skill and knowledge to use e-collars effectively and safely on their dogs, and, whenever possible, they should be encouraged to receive hands-on instruction from skilled trainers and other experienced professionals (p.626).

He goes on to state:

> "The humane use of electronic training equipment depends on an educated end-user; oddly enough, though, few manufacturers have come to grips with their responsibility in this regard, and, along with pet supply retailers, appear content with the status quo and short-term profits to a relatively ignorant dog-owning public—a state of affairs that is difficult to fathom when one considers the high stakes. Eventually, this strategy may prove foolhardy, perhaps leading concerned individuals and organizations critical of such devices to seek legislative action to restrict their sale and use by the public altogether." (Lindsay p.627)

APPENDIX A: DEFINITIONS OF ELECTRICAL TERMS

Ampere:

1. A measure of electrical current flow.

2. A measure of how much electricity is moving through a conductor.

3. The unit of measurement of electric current. It is proportional to the quantity of electrons flowing through a conductor past a given point in one second. It is analogous to cubic feet of water flowing per second.

4. The unit of measurement used to determine the quantity of electricity flowing through a circuit. One ampere flows through a one ohm resistance when a potential one volt is applied.

5. One ampere is the current flowing through one ohm of resistance at one volt potential. Analogous to gallons of water flowing past a given point.

mA:

1. Milliampere: one thousandth of an ampere.

1. Milliamps, 1000 MA = one amp.

Impedance:

Impedance is a measure of how hard a signal has to work to get through a cable, speaker, or piece of equipment. Always rated in ohms, the higher the impedance, the harder for the signal to get through a material's opposition to the flow of electric current; measured in ohms.

Ohm:

1. The amount of resistance overcome by one volt in causing one ampere to flow. The ohm measures resistance to current flow in electrical circuits.

2. A measure of how much something resists (impedes) the flow of electricity. Larger numbers mean more resistance.

3. A unit of electrical resistance equal to that of a conductor in which a current of one ampere is produced by a potential of one volt across its terminals.

4. One ohm is the value of resistance through which a potential difference of one volt will maintain a current of one ampere.

5. Unit of electrical resistance used to measure a material's resistance to the flow of electric current.

APPENDIX B: WEB RESOURCES

The following Web sites have articles on the use of electronic training devices:

Smith, C. (2006). What do you say when your clients want electronic containment systems. *Animal Behavior Consulting: Theory and Practice*, 2(1), 27-32. www.iaabc.org.

Shock collars: The shocking truth. *Association of Pet Behavior Counsellors*, www.apbc.org.uk.

The Delta Society, www.deltasociety.org, *Section 3.10, Remote Training Collar*.

REFERENCES

Ahn A., Wu J., Badger G., Hammerschlag R., & Langevin H. (2005). Electrical impedance along connective tissue planes associates with acupuncture meridians. *BMC Complementary and Alternative Medicine*, *5*, 10.

Anderson D.E. & Brady, J.V. (1971). Preavoidance blood pressure elevations accompanied by heart rate decreases in the dog. *Science*, *172*(983), 595-7.

Andelt W.F., Phillips, R.L., Gruver,K.S., & Guthrie,J.W. (1999). Coyote predation on domestic sheep deterred with electronic dog-training collar. *Wildl Soc Bull, 27*, 12-18.

Beerda B. (1998) Behavioral, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science, 58*, 365-381

Beerda B., Schilder M.B., & van Hooff J.A. (1999). Chronic stress in dogs subjected to social and spatial restriction. *Journal of Behavioral Responses*, *66*, 233-42

Bolshakov V., Kandel E., Benes F., Carlezon W., & Tsevtkov E. (2002). Fear conditioning occludes LTP-induced presynaptic enhancement of synaptic transmission in the cortical pathway to the lateral amygdala. *Neuron*, *34*, 289-300.

Borshelt, P.L. (1983). Aggressive behavior of dogs kept as companion animals: classification and influence of sex, reproductive status and breed. *Applied Animal Ethology, 10*, 45-61.

Brush, F.R. (1957). The effects of shock intensity on acquisition and extinction of an avoidance response in dogs. *J Comp Physiol Psychol*, *50*(6), 547-552.

Christiansen, F.O., Bakken, M., & Braastad, B. (2001A). Behavioral changes and aversive conditioning in hunting dogs by the second-year confrontation with domestic sheep. *Applied Animal Behaviour Science, 72*(2), 131-143.

Dess, N.K., Linwick, D., Patterson J., et al (1983). Immediate and proactive effects of controllability and predictability on plasma cortisol responses to shock in dogs. *Behavioral Neuroscience*, *97*, 1005-1016.

Dykman, R.A. & Gantt, W.H. (1997). Experimental psychogenic hypertension: Blood pressure changes conditioned to painful stimuli (schizokinesis). *Integr Physiol Behav Sci, 32*, 272-287. (Originally published by the *Bulletin of the Johns Hopkins Hospital*, Aug 1960, Vol 107).

Engeland,W.C. (1990) Pituitary-adrenal and adrenomedullary responses to noise in awake dogs. *Am J Physiol Regul Integr Comp Physiol, 258*, R672-R677.

Friedberg, J. (1928). Shock treatment, brain damage and memory loss: A neurological perspective. *American Journal of Psychiatry*, *134*(9), 1010-4.

Gershman, K.A. (1993). Which dogs bite? A case–control study of risk factors. *Pediatrcs*, *93*(6, Pt1), 913-7.

Guy, N.C., Luescher, U.A., Dohoo, S.E., et al. (2001A). A case series of biting dogs: characteristics of the dogs, their behaviour and their victims. *Applied Animal Behavior Science*, *74*, 43-57.

Guy, N.C., Luescher, U.A., Dohoo, S.E., et al. (2001B). Risk factors for dog bites to owners in general veterinary caseload. *Applied Animal Behavior Science*, *74*, 29-42.

Hilby, E.F., Rooney, N.J., & Bradshaw, J.W.S. (2004). Dog training methods: Their use, effectiveness and interaction with behaviour and welfare. *Animal Welfare*,*13*, 63-69.

Houser, V.P. & Pare, W.P. (1974). Long-term conditioned fear modification in the dog as measured by changed in urinary 11-hdyrocorticosteroids, heart rate and behavior. *Pavlovian Journal of Biological Science, 9*, 85-96.

Jones, A.C. & Josephs, R.A. (2005). Are we dog's best friend? Predicting canine cortisol. *Current Issues and Research in Veterinary Behavioral Medicine.* West Lafayette, Indiana: Purdue University Press, 194-197.

Kaczmarek, K.A. et al. (1991). Electrotactile and vibrotactile display for sensory substitution systems. *IEEE Trans Biomed Eng*, *38*,1-16.

King, T., Hemsworth, P.H., & Coleman, G.J. (2003). Fear of novel and startling stimuli in domestic dogs. *Applied Animal Behavior Science*, *82*, 45-64.

Lessac, M.S. & Solomon, R.L. (1969). Effects of early isolation on the later adaptive behavior of beagles: A methodological demonstration. *Developmental Psychology, 1:14-25.*

Linsday, S. (2005). Biobehavioral monitoring and electronic control of behavior. *Handbook of Applied Dog Behavior and Training: Procedures and Protocols, Vol 3.* Ames, Iowa: Blackwell Publishing, 557-627.

Lynch, J.J. & McCarthy, J.F. (1967). The effects of petting on classically conditioned emotional response. *Behavior Research and Therapy*, *5* (Issue 1), 55-62.

Marder, A.R. & Voith, V. (1991). Defining and assessing physical and psychologic well-being. *The Veterinary Clinics of North America,* 21(2) March 1991 W.B. Saunders, 371-373.

Moyer, K.E. (1968). Kinds of aggression and their physiological basis. *Common Behavioral Biology*, *2*, 65-87.

Overall, KL, (1997) Treatment of behavioral problems. *Clinical Behavioral Medicine for Small Animals,* St Louis, Mo., Mosby Publishing, 289.

Polsky, R.H. (1994). Electronic shock collars–Are they worth the risk? *Journal of the American Animal Hospital Association, 30:* 363-468

Polsky, R.H. (1998). Shock collars and aggression in dogs. *Animal Behavior Consultant Newsletter*, *15*, 2.

Polsky, R.H. (2000). Can aggression be elicited through electronic pet containment systems? *Journal Applied Animal Welfare Science, 3*, 345-357.

Reisner, I.R. (2003). Differential diagnosis and management of human-directed aggression in dogs. *The Veterinary Clinic Small Animal Practice*, *33*, 303-320.

Sang, C.N., Max, M.B., & Gracely, R.H. (2003). Stability and reliability of detection thresholds for human A-Beta and A-delta sensory afferents determined by cutaneous electrical stimulation. *Journal of Pain and Symptom Management*, *25*, 64-73.

Schalke, E., Stichnoth, J., Ott,S, & Jones-Baade, R.(2006) Clinical Signs caused by the use of electric training collars on dog in everyday life situations. *Journal of Applied Animal Behavior Science, doi:10.1016/j.japplanim.2006.11.002*

Schilder, M. & van der Borga, J. (2004). Training dogs with the help of the shock collar: Short and long term behavioral effects. *Applied Animal Behavior Science, 85*, 319-334.

Seligman, M.E.P. & Maier, S.F. (1967). Failure to escape traumatic shock. *Journal of Experimental Psychology*, 74, 1-9.

Seligman, M.E.P., Maier, S.F., & Geer, J.H. (1968). Alleviation of learned helplessness in the dog. *Journal of Abnormal Psychology*, 73, 256-272.

Shivik, J.A., Treves, A., & Callahan, P. (2003) Nonlethal techniques for managing predation: Primary and secondary repellents. *Conservation Biology*, 17:1531-1537.

Soltysik, S. & Jelen, P. (2005). In rats, sighs correlate with relief. *Psychology & Behavior*, *85,* 598-602.

Tagliabue, A., Andreoli, A., Comelli, M., Bertoli, S., Testolin, G., Oriani, G., & DeLorenzo, A. (2001). Prediction of lean body mass from multifrequency segmental impedance: influence of adiposity. *Acta Diabelol, 38*(2), 93-7.

Vincent, I.C. & Mitchell, A.R. (1992). Comparison of cortisol concentrations in saliva and plasma in dogs. *Research in Veterinary Science.* 53, 342-345.

Vincent, I.C. & Leahy, R.A. (1997). Real-time non-invasive measurement of heart rate in working dogs: A technique with potential application in the objective assessment of welfare problems. *Veterinary Journal*, 153, 179-184.