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The effects of using aversive training methods in dogs—A review

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ABSTRACT

The purpose of this study was to review a series of studies (N = 17) regarding the effects of using various methods when training dogs. The reviewed studies examined the differences between training methods (e.g., methods based on positive reinforcement, positive punishment, escape/avoidance, et cetera) on a dog's physiology, welfare, and behavior toward humans and other dogs. The reviewed studies included surveys, observational studies, and interventions. The results show that using aversive training methods (e.g., positive punishment and negative reinforcement) can jeopardize both the physical and mental health of dogs. In addition, although positive punishment can be effective, there is no evidence that it is more effective than positive reinforcement–based training. In fact, there is some evidence that the opposite is true. A few methodological concerns arose from the reviewed studies. Among them are small sample sizes, missing data on effect size, possible bias when coding behavior in observational studies, and the need to publish case reports of bodily damage caused by aversive training methods. In conclusion, those working with or handling dogs should rely on positive reinforcement methods and avoid using positive punishment and negative reinforcement as much as possible.

Introduction

Domestic dogs are an integral part of human culture, and their welfare is an important concern for owners, caretakers, veterinarians, behavior specialists, and all those working or handling them. Much controversy exists in the veterinary and the dog training community regarding the efficacy and possible negative unintended outcomes of various training methods of dogs. These training methods can range from reward-based to aversive, and individuals who work with dogs choose training methods based on several factors such as their level of education, their previous success with different methods, and their individual set of morals.

Both classical and operant conditioning processes are usually involved in any dog training method. These processes have been researched extensively, and information about them can be found in both academic (e.g., Chance, 2003) and professional (e.g., Reid, 1996) books. For the purpose of this review, it is important to briefly define classical and operant conditioning. Classical conditioning is the process of pairing a neutral stimulus (e.g., the conditioned stimulus) with an unconditioned stimulus (e.g., food) (Chance, 2003). This process allows an animal to make an association between the 2 stimuli. In contrast, operant conditioning is a procedure in which a behavior becomes stronger or weaker depending on its consequences (Chance, 2003). In general, there are 4 possible consequences in operant conditioning: (1) positive reinforcement—a behavior is strengthened by the presentation of a stimulus (that the animal wants), (2) negative reinforcement—a behavior is strengthened by the removal of an unpleasant stimulus that the animal wants to avoid, (3) positive punishment—presenting an unpleasant stimulus that causes a reduction in the strength of a behavior, and (4) negative punishment—the removal of a stimulus that the animal seeks out, which causes a reduction in the strength of a behavior (Chance, 2003).

Traditional training methods tend to rely on positive punishment and negative reinforcement. Unfortunately, using these operant principles can have negative effects on dogs' health and behavior (Beerda et al., 1998). In his book "Coercion and its Fallout," Murray Sidman suggests that "…what makes the noncoercive alternatives necessary…is the vast catalog of punishment's side effects—consequences of punishment that cancel out its benefits…" (Sidman, 2000, p. 80). Indeed, using punishment can be accompanied by a number of possible undesirable, negative, and

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potentially injurious (to the learner) effects, such as escape behavior, aggression, and apathy (Chance, 2003). Importantly, although negative reinforcement uses a removal of an unpleasant stimulus, this stimulus must first be presented. Thus, the presentation of the unpleasant stimulus can be considered positive punishment for the behavior that occurred just before its appearance. As Sidman (2000) suggested, negative reinforcement and punishment involve the same events but which function differently. It is often unappreciated that negative reinforcement involves coercion, which is accompanied by negative unintended outcomes as well (e.g., prevents an animal from relaxing its vigilance, causes fearfulness of novelty, and causes reluctance to explore) (Sidman, 2000). In contrast to training methods that use positive punishment and negative reinforcement, other methods rely mainly on positive reinforcement which, according to Sidman (2000), is not coercive. Positive reinforcement carries less risk of negative unintended outcomes.

The debate among trainers who tend to use positive punishment and negative reinforcement and those who prefer methods that rely on positive reinforcement is ongoing. For example, in 1 editorial, Overall (2007) explained why electronic collars (which deliver electronic shocks to the dogs and are usually used as positive punishers or negative reinforcers) are not and should not be used for behavior modification in dogs, because of their aversive nature and due to the lack of scientific data on their effectiveness. However, others suggest that such collars can be an effective training tool (e.g., Christiansen et al., 2001). Although using positive punishment and negative reinforcement can be effective, the question of whether using them is ethical or not is open to debate. Friedman (2009) suggests that the relative intrusiveness of behavior modification techniques should be examined and that minimally intrusive (but still effective) methods should be used. Friedman (2009) suggests that behavior interventions should not be chosen solely because they are convenient or effective since they may produce detrimental unintended outcomes in the learner.

Because there are contrasting opinions regarding the use of different dog training methods, it is important to provide as much data as possible on this topic. Such data will allow practitioners to choose training methods wisely and thus provide effective and minimally aversive behavior modification tools to dog owners and to those working with or caring for dogs. Hence, the purpose of this review was (1) to review the literature regarding the effects of different training techniques (e.g., positive punishment and/or negative reinforcement vs. positive reinforcement) on dogs' behavior and welfare and (2) to suggest possible implications of the research findings to other researchers and to those working with or caring for domestic dogs.

Methods

A search for articles written in the English language was conducted using 3 computerized databases: Scopus, Google Scholar, and PubMed. A combination of the following terms was used: punishment in dog training, aversion, punishment, shock collars, electronic collars, choke collars, prong collars, dog training methods. A manual search of the reference lists from the relevant articles was performed as well. The search was completed in October, 2016. Only articles that directly compared the effects of 2 or more training methods on dogs' behavior and welfare were included. Articles that were published in nonacademic journals were excluded from this review. The search yielded 17 studies, which are reviewed in the current article and are summarized in Table.

Results

The results are divided into 4 sections. The first section reviews articles that compared different training methods; the second section examines dog-to-dog aggression; the third section reviews studies on the use of electronic collars or electronic pet containment systems; and the fourth section examines the effects of aversive training techniques on the physical health of dogs.

Comparison between training methods

One survey of 326 dog owners examined whether the use of different training methods was related to the level of obedience and to the occurrence of behavior problems in dogs aged more than 1 year (Hiby et al., 2004). The results revealed that punishment-based training methods were related to a larger number of reported behavior problems compared to reward-based training. In addition, the highest obedience scores were reported by owners who used reward-based training only, followed by those who used a combination of reward and punishment-based methods, and lastly by those using punishment only. As Hiby et al. (2004) indicated, the results of this survey suggest that reward-based training methods are associated with both higher levels of obedience and fewer behavior problems in dogs owned by a population of average dog owners.

Another survey of 192 dog owners was conducted in the United Kingdom (Blackwell et al., 2008). The training techniques were listed in 3 categories: (1) positive reinforcement, (2) negative reinforcement, and (3) positive punishment. No techniques were categorized as negative punishment. However, some of the training techniques reported as negative reinforcement should have been categorized as negative punishment (e.g., withdrawing of attention/time out, and withdrawing of rewards). Hence, the relationship between negative reinforcement and dogs' behavior is difficult to interpret. Regardless, the use of punishment when training dogs was related to an increase in both fear and aggression. In contrast, using positive reinforcement only was associated with the lowest scores on fear, aggression, and attention-seeking behaviors. Using a combination of positive reinforcement and positive punishment was related to the highest aggression scores (Blackwell et al., 2008).

A third survey of 140 dog owners who scheduled an appointment for treating their dog's behavior problems in a veterinary hospital (Herron et al., 2009) revealed that direct and indirect confrontational training methods were related to aggressive behavior. For example, yelling "no" at the dog was related to aggression in 15% of the cases (18 of 122 dogs); performing an "alpha roll" (i.e., forcefully putting the dog on its back and holding it down) was related to aggression in 31% of the cases (11 of 36 dogs); hitting or kicking the dog was related to aggression in 41% of the cases (12 of 28 dogs); forcefully releasing an item from the dog's mouth was related to aggression in 38% of the cases (15 of 39 dogs); using a spray bottle was related to aggression in 20% of the cases (10 of 51 dogs); and grabbing the dog by the jowls or scruff was related to aggression in 26% of the cases (7 of 27 dogs). In contrast, using neutral or reward-based methods was rarely related to aggressive behaviors.

A fourth survey of 3,897 dog owners found that compared to positive reinforcement and negative punishment, the use of positive punishment and negative reinforcement was related to an increased risk for aggression toward family members (odds ratio 2.9) and toward unfamiliar people outside of the house (odds ratio 2.2) (Casey et al., 2014).

Finally, it is possible that factors such as a dog's size, breed, age, and sex can affect owners' behavior and choice of training methods. A survey of 1,276 dog owners compared the relationship between

Table
A summary of studies of the effects of aversive training methods on dogs (N = 17, studies are presented by year of publication and name of first author)

Study	Animals and participants	Method	Measures	Results
Roll and Unshelm, 1997	Dog owners with a dog injured by another dog (n = 151) and dog owners with a dog that injured another dog (n = 55).	Questionnaires completed by all owners to compare aggressors and victims.	Sex Breed Age Training methods Degree of injury Location of fight Owners' demographics	Only descriptive statistics reported. Dogs that were trained by hitting or "shaking" tended to have a history of biting other dogs. A higher % of victim dogs were owned by dog owners who shouted and gave clear commands and owners who believed that training should be fun and that it was advantageous to have a trained dog. A higher % of aggressor dogs were owned by owners who believed that a dog would be out of control without training.
Polsky, 2000	Adult dogs (n = 5).	Descriptive data collected in the form of legal documents, animal control officers and police officers' reports. Case studies of aggression that was elicited by electronic pet containment systems were examined.	Dog sex, age, reproductive status, breed, location of attack relative to border of containment system, and victim's familiarity with dog	All 5 attacks carried out by adult intact males between the ages of 2-3 years. Adult victims were familiar with the dog, child victims were not. In 4 of 5 cases, the dog received a shock at the time of the attack. Not 1 of the dogs showed threatening behavior before attack. All attacks included repeated biting of victim. No gross warning signals were given before biting.
Hiby et al., 2004	Dog owners (n = 326) with dogs aged more than 1 year.	Questionnaires given to dog owners as they were walking their dog or through veterinary clinics. Questionnaires returned by mail.	Demographics Training methods Obedience level Problem behaviors	Using punishment positively correlated with problem behaviors. No correlation between use of reward-based training and problem behaviors. Number of behavior problems: punishment only > combination of punishment and reward > reward only or miscellaneous methods. Punishment-based training was never the most effective for achieving obedience goals. Overall obedience was related to reward-based but not to punishment-based methods.
Schilder and van der Borg, 2004	Dogs that were trained for official certificate of police service (n = 15). Dogs that trained with (n = 16) and without (n = 15) electric shocks.	Videotaping 107 shocks delivered to 31 dogs and comparing body language to control dogs that did not receive shocks. Comparing behavior of dogs that received shocks in the past to dogs that did not.	Direct effect of shocks on body language. Body language of dogs that received shocks in the past during various conditions in which no shocks were given	Direct reaction to shocks (e.g., lowering body, high-pitched yelps, barks, squeals, redirected aggression, avoidance) lasted a fraction of a second. Long-term effects: comparison of shocked (S) dogs and control dogs (C). During free walking, obedience, and police work: lower ear postures and stress-related behaviors: S > C. Differences were seen even when walking in a park outside the training grounds. Stress and lower ear postures: training > free walking.
Schalke et al., 2007	Laboratory-bred Beagles between the ages of 1.5-2 years (n = 14).	Training to stop prey behavior. Three groups: (1) receive shock precisely at the moment they touch a prey dummy, (2) receive shock when failing to obey a recall during hunting, (3) receive arbitrary, unpredictable shocks.	Heart rate Salivary cortisol	Absolute and relative cortisol levels: Group (1)—increase by ~22 and 31%, respectively. Group (2)—increase by ~114 and 160%, respectively. Group (3)—increase by ~336 and 328%, respectively. Increase in maximal heart rate in group (3) on days of training with shock.

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Study	Animals and participants	Method	Measures	Results
Steiss et al., 2007	Dogs from a private no-kill shelter (n = 21).	Dogs randomly assigned to 3 groups: control (C), electronic antibark collar (E), lemon spray antibark collar (S). Baseline measurements and measurements after collar was activated.	Barking Activity Plasma cortisol ACTH	Reduced barking in S and E groups compared to C. No statistically significant changes in plasma cortisol and ACTH. However, large effect sizes of increased plasma cortisol and ACTH in S and E groups on day 1 of wearing the active collar compared to baseline.
Blackwell et al., 2008	Dog owners (n = 192) with dogs between the ages of 1-15 years.	Questionnaires given to dog owners walking their dogs or in veterinary hospitals in the United Kingdom.	Demographics Training methods Obedience level Problem behaviors	Training methods: 16% R+, 12% R+ and R−, 32% R+ and P+, 40% combination of all categories. 72% used some P+. R+ only: lowest score on attention seeking behaviors, fear, and aggression. R+ and R−: highest score on attention seeking behavior. R+ and P+: highest score on aggression. Reactivity to other dog and people: lowest in R+ only. Fear and aggression problems higher in dogs that received any type of punishment.
Haverbeke et al., 2008	33 dog and handler teams of the Belgian Defense. Dogs between the ages of 1-5 years and have been working between 3 months and 3 years.	Standardized evaluation of 8 obedience exercises and 5 protection work exercises to assess teams' performance. Two evaluations with 20 days in between were performed. Dogs divided into high-performance and low-performance groups.	Team performance Handler's behavior Dog behavior	Team performance: 66% success in obedience and 39% success in protection work. Use of R+ (57.12%) > use of aversive stimuli (R− and P+) (21.88%). Use of aversive stimuli: protection work > obedience high-performance < low-performance dogs distracted dogs > slightly distracted, not distracted 2nd evaluation > 1st evaluation. Dogs showed lower posture after aversive stimuli in the 2nd compared to the 1st evaluation
Herron et al., 2009	Dog owners who scheduled an appointment for behavior consultation in a veterinary hospital (n = 140).	Survey regarding previous behavior interventions and outcomes sent by email, fax, or postal mail to owners. Survey included a list of 30 possible interventions. Interventions categorized by researchers to: aversive, indirect confrontation, reward training, and neutral.	Frequency of intervention use Aggressive response due to intervention. Effect of intervention on behavior problem	% of dogs responding aggressively to confrontational training methods: "Alpha roll" (31%), forced release of item in dog's mouth (38%), hit or kick dog (43%), grab jowls/scruff (26%), "dominance down" (29%). % of dogs responding aggressively to indirect confrontational training methods: "stare down" (30%), water pistol/spray bottle (20%), growl at dog (41%), yelling "no" (15%). Only between 0%-6% of dogs responded aggressively to neutral and reward-based methods.
Arhant et al., 2010	Survey randomly sent to 5000 dog owners. 1,405 surveys returned, 1,276 analyzed.	Questionnaire with 237 short questions regarding demographics, and dog and owner behavior. Comparison between small (<20 kg) and large (>20 kg) dogs.	Dog behavior Training techniques used	Using P+: small = large dogs. Higher frequency of punishments related to higher aggression and excitability scores in small and large dogs. Relationship between punishment and aggression stronger in small dogs. Relationship between punishment and fearfulness and anxiety found only in small dogs. Use of reward-based responses to unwanted behavior related to higher frequency of aggressive behavior. All correlations < 0.3

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Study	Animals and participants	Method	Measures	Results
Rooney and Cowan, 2011	Dog owners and their dogs (n = 53).	Researcher visited and filmed the behavior of each owner and dog at their home while following specific instructions including ignoring the dog and performing obedience exercises. Owners also completed a questionnaire.	Owner-reported training methods Dog behavior Owner behavior	None of the 54 owners reported using reward-based or punishment-based methods exclusively. Proportion of punishment-based methods negatively correlated with dog interaction with experimenter. Proportion of reward-based training methods positively correlated with dog performance at a novel task. Using physical punishment: dogs less interactive during play and less likely to interact with experimenter (compared to not using physical punishment at all). Dog performance in novel task positively correlated with total rewards delivered and owner patience.
Blackwell et al., 2012	14,566 questionnaires distributed to dog owners, 27% returned (n = 3,897).	Questionnaires regarding demographics, choice of training method, and prevalence of undesired behaviors.	Training method Problem behavior Demographics Training success	Only 3.3% reported using E-collars, 1.4% bark E-collars, and 0.9% electronic containment system. Higher % of owners using reward-based methods reported success for recall/chasing problems (~97%) compared to E-collar use (~83%) or other aversive methods (~94%). Occurrence of undesired behaviors did not differ between training methods.
Salgirli et al., 2012	Adult police dogs (n = 42).	Setup of training exercise with human decoys meant to distract the dog into breaking a heel. Repeated-measures design. Counterbalanced order of 3 aversive stimuli: (1) quitting signal, (2) pinch collar, (3) E-collar. One week between conditions for each dog.	Salivary cortisol Behavioral observations	Use of E-collar and pinch collar led to learning to disregard the distraction while heeling. % of dogs with behavior reactions to punishment: no statistically significant differences between pinch (64.3%) and electronic (38.1%) for extreme backward ears. Extreme low body posture: 4.8% of dogs for pinch, 0% E-collar. Vocalization: ~60% E-collar > ~23% pinch. # of dogs with maximal salivary cortisol values: 17 quitting signal, 15 E-collar, 10 pinch. Highest cortisol concentration after quitting signal.
Grohmann et al., 2013	1-year-old intact male German Shepherd.	A case study of severe brain damage after punitive technique with a choke collar.	Description of punishment Description of symptoms	Dog suspended a few feet in the air by a choke collar for approximately 60 seconds. Dog panicked and lost consciousness. After a few hours, dog became ataxic on all 4 limbs and was circling to left. Several neurological symptoms. MRI revealed legions which led to a diagnosis of severe cerebral edema due to ischemia. Owner chose to euthanize the dog.
Casey et al., 2014	Same questionnaire as Blackwell et al., 2012. 14,566 questionnaires distributed to dog owners, 27% returned (n = 3,897).	Questionnaires regarding demographics, choice of training method, and prevalence of undesired behaviors.	Risk factors for aggressive behavior	Compared to R+ and P−, using P+ and/or R− were related to increased risk of aggression toward members of the family and toward unfamiliar people outside the house (odds ratio 2.8 and 2.2, respectively).

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Study	Animals and participants	Method	Measures	Results
Cooper et al., 2014	63 dogs (no differences between groups in age, sex, and breed) divided to 3 groups based on dog characteristics and past training history.	Examining effects of E-collar use on dogs' welfare. Three groups trained for 5 days (2 sessions per day) for recall in the presence of distractions: (1) E-collar use, (2) same trainers with no use of E-collar, (3) trainers who don't advocate E-collar use and no use of E-collar.	Behavioral and physiological measures before, during, and after training	Training success: no differences between groups in owners' satisfaction and perception of dogs' improvement. Behavioral measures: time spent in tense state: 1 > 2, 3 Low tail carriage: 1, 2 > 3 Yawning: 1 > 3 Vocalization increase with E-collar intensity increase. # of commands given: 1, 2 > 3 (twice as many) Interaction with environment: 1, 2 < 3 Salivary cortisol: 3 >1, 2 throughout study. Post-training minus pretraining cortisol: 1 = 2 = 3
Deldalle and Gaunet, 2014	Dogs in advanced training class from 2 schools: R+ school (n = 24), R− school (n = 26).	Observation of owner and dog performance of a walk on leash and a sit command in advanced group classes.	Performance Dog behavior Owner behavior	While walking on leash: % of dogs gazing at owner: R+ (63%) > R− (4%). During the "sit" command: # of dogs showing mouth licking and yawning and showing at least 1 of 6 stress-related behaviors: R− > R+. % of dogs gazing at owner: R+ (88%) > R− (38%). % of dogs with low body posture: R − (46%) > R+ (8%).

ACTH, adrenocorticotropic hormone; E-collar, electronic collar; MRI, magnetic resonance imaging; R+, positive reinforcement; R−, negative reinforcement; P+, positive punishment.

training methods and behavior in small (<20 kg) and large dogs (>20 kg) (Arhant et al., 2010). As in previous surveys, positive relationships between the use of punishment and excitability, and between punishment and aggression, were found in both small and large dogs. A relationship between punishment and fearfulness was found in small dogs only. In addition, reward-based responses to behavior problems (e.g., calming or distracting the dog) were related to aggression as well. Correlation values were low to moderate (usually <0.3). In addition, the cutoff weight for small and large dogs (i.e., 20 kg) may not have been specific enough to reveal differences in dogs of different sizes.

In summary, it appears that the use of training methods that are based on positive punishment and negative reinforcement are related to higher incidences of behavior problems, aggression, and fear. Reward-based responses to behavior problems were related to aggression only in 1 study (Arhant et al., 2010). It is important to note, however, that the 5 reviewed studies (i.e., Arhant et al., 2010; Blackwell et al., 2008; Casey et al., 2014; Herron et al., 2009; Hiby et al., 2004) were based on the owners' subjective answers to questionnaires and are prone to methodological difficulties such as recall bias and the misunderstanding of terms or questions that were presented in the questionnaires. In addition, causality cannot be established from the data in these studies, as it is not known whether the dogs' aggression or the presence of behavior problems led to the use of aversive training methods, or if the use of aversive training methods caused aggression and other behavior problems. Hence, the results of such studies should be interpreted appropriately and serve as a basis for future studies that are based on direct observation or specific interventions, rather than as a basis for causal inference. In future studies, researchers should also take into account the dogs' size as a covariate in their statistical analysis, as it can have an effect on dog owners' choice of training methods.

Finally, at least according to 1 study (Blackwell et al., 2008), inconsistency in training methods was related to the highest aggression scores. As the authors of this study suggested, it is possible that the inconsistency in training methods led to uncertainty or anxiety in the dogs, which in turn led to aggressive behavior. It is also possible that this finding merely suggests that owners tried a variety of training methods to modify aggressive behavior. As this is the only study that reported this finding, more research on this topic is warranted.

Studies with direct observations of dogs

Researchers in 3 studies directly observed the training techniques and the behavior of owners and their dogs (Deldalle and Gaunet, 2014; Haverbeke et al., 2008; Rooney and Cowan, 2011).

In 1 study, one of the researchers visited the home of each of 53 dogs and their owners and conducted several tests of behavior and obedience (Rooney and Cowan, 2011). All sessions were filmed, and a history of training methods used by owners was obtained. The dogs of owners who tended to use punishments showed less interaction with the experimenter. In addition, dogs that were trained with physical punishment were less likely to approach a stranger and played less with their owners. It was also found that dogs that were mostly trained with reward-based methods scored higher in their ability to learn a novel task.

In another exploratory study (Deldalle and Gaunet, 2014), one of the researchers observed training classes at 2 dog training schools. In one school, the dogs were trained using positive reinforcement, and in the other school, they were trained with negative reinforcement. The researcher observed and recorded the dogs' behavior as they were walking on a leash and responding to the "sit" command from their owners. More dogs showed stress-related behaviors and low body postures in the negative reinforcement group compared to the positive reinforcement group. In addition, fewer dogs gazed at their owners in the negative reinforcement group, compared to the positive reinforcement group (during walking on leash, 4% [1 of 26 dogs] vs. 63% [15 of 24 dogs], respectively; during the "sit" command, 38% [10 of 26 dogs] vs. 88% [21 of 24 dogs], respectively). These results suggest that dogs' welfare may be threatened by the use of negative reinforcement. Moreover, the data on gazes toward the owner may suggest that the relationship between owner and dog can be compromised when training with negative reinforcement. However, it is also possible that the dogs from the positive reinforcement school looked at their owners because they were waiting for a reward or that they were reinforced more often for this behavior compared to the dogs from the negative reinforcement school. It is important to note that positive punishment and negative punishment were not evaluated in this study. Both the history of punishment and the acute punishments delivered throughout the training sessions could have affected the results of this study. For example, when using positive reinforcement, the withdrawal of food can be considered negative punishment. In contrast, in order for a stimulus to serve as a negative reinforcement, one has to apply positive punishment first so that there will be an aversive stimulus to remove.

Finally, a third study carried out evaluations of the performance of 33 military dog-handler dyads when performing standardized obedience exercises and protection work (Haverbeke et al., 2008). In general, the teams' performance (i.e., score based on correct and incorrect exercises) was relatively low, with ~66% success in obedience exercises and ~39% success in protection work exercises. Dogs that received more aversive stimuli (either positive punishment or negative reinforcement—e.g., pulling on the leash, hanging dog by collar, verbal scolding, hitting) were more distracted and showed poorer performance compared to dogs that received less-aversive stimuli. In addition, the dogs showed a lower posture after the infliction of aversive stimuli by their handlers. The authors of this study suggested that the welfare of dogs that received aversive stimuli during training was threatened, although this could not be directly proven by the data.

In summary, the reviewed studies suggest that aversive training methods (e.g., positive punishment and negative reinforcement) may negatively affect the behavior and welfare of dogs. Moreover, none of the studies showed any evidence that aversive training methods are more effective than reward-based training. In fact, according to Haverbeke et al. (2008), the opposite appears to be true. Hence, those working with dogs are encouraged to rely on reward-based training methods.

However, 2 limitations are noteworthy. First, although observational studies provide more robust data than surveys, they still do not necessarily provide support for causation. Second, in the first study (Rooney and Cowan, 2011), only the researcher who visited the dogs rated their behaviors. This researcher also interviewed the owners. Hence, as the authors mentioned, there is a risk for unconscious bias. Similarly, in the second study (Deldalle and Gaunet, 2014), only 1 researcher recorded the behaviors of dogs while visiting the training centers. In the third study (Haverbeke et al., 2008), the authors did not report whether more than 1 researcher rated the behaviors. In future studies, 2 researchers—preferably blind to the hypotheses or study groups—should code behaviors, and interrater reliability should be reported.

Finally, because only 2 training schools were compared by Deldalle and Gaunet (2014), individual variations could have led to some of the reported differences. Hence, as the authors of this study suggested, future studies should include a larger sample of training schools to compensate for these individual variations.

Dog-to-dog aggression

Only 1 study examined the relationship between training methods and dog-to-dog aggression (Roll and Unshelm, 1997). Questionnaires were given to dog owners with a dog that was injured by another dog (n = 151) and dog owners with a dog that had injured another dog (n = 55) while they were in a veterinary clinic. The results showed that dogs that were trained by hitting or "shaking," and dogs owned by individuals who believed that without training a dog will be out of control, tended to be on the aggressor side of the dog-to-dog aggression. In contrast, dogs of owners who believed that training should be fun and that it would be advantageous to have a trained dog were found to be more often on the victim side. In addition, dogs of owners who shouted and gave clear commands were also found more often on the victim side. The explanation for the last finding is not readily apparent. It is possible that the dogs that were on the receiving end of shouting were more fearful in general and had been punished for previous displays of aggression.

Electronic collars and electronic containment systems

The use of electronic collars is highly controversial. Some trainers suggest that such collars are effective in modifying behavior, whereas other trainers find them inhumane and avoid using them. When possible, practitioners should base their choices of training methods on scientific data. Hence, data on the relationship between the use of electronic collars and dogs' behavior are described in this section.

Observational studies and surveys

In 1 study (Polsky, 2000), descriptive data about dog aggression that may have been elicited by electronic containment systems were collected. Five cases in which dogs inflicted multiple uninhibited bites on humans in the presence of an active electronic containment system were found. In all cases, the dog was an intact male with no prior displays of aggression. During the attack, all dogs failed to show gross warning signs (e.g., snarling, growling) before biting. In 4 of the 5 attacks, the dogs received a shock before the attack. These results should be read with caution, as the data were collected from legal reports and the behavior was not directly observed by trained professionals. Still, because all of the dogs had not shown serious aggression before the incident, it is plausible that the aggressive behavior was elicited by the shock, by the classically conditioned response to a threat tone that precedes the shock, or by a response to other environmental stimuli that preceded the shock.

In contrast to the previous study, a survey of 3,897 dog owners did not find any difference in undesirable behaviors among those using various training techniques (Blackwell et al., 2012). Results showed that only a small proportion of dog owners used electronic collars (3.3%, N = 133), electronic bark collars (1.4%, N = 54), or electronic containment systems (0.9%, N = 36). It is possible that these small numbers prevented a meaningful statistical comparison between methods. As for training effectiveness, the reported training success for teaching a dog to come when called or to prevent the dog from chasing was higher in the reward-based group compared to the electronic collars group. However, this could be due to a number of confounding factors, such as the seriousness of the problem behavior and owners' perception of success.

Finally, the effects of using electronic collars were examined in a study that directly observed 32 dogs that were trained as police service dogs or watchdogs (Schilder and van der Borg, 2004). The researchers also observed the behavior of dogs that were shocked in past training with dogs that had never received shock before. Dogs trained with electronic collars vocalized and presented body postures associated with stress or fear (e.g., tongue flicking, lowering ear positions, lowering of the body/tail) for a fraction of a second after receiving an electric shock. Both during free walking and during training sessions without shocks, dogs that were trained with shocks in the past showed more stress-related behaviors than dogs that were not trained with shocks. In addition, shocked dogs were more stressed than control dogs on the training grounds and also in a park unrelated to training. The fact that stress-related behaviors were seen outside the training grounds, but in the presence of the handlers, suggests that dogs associate the possibility of getting shocked with the presence of their handlers. The authors of this study concluded that using electronic shocks for training is not only unpleasant but is also painful and frightening for the dogs. Hence, it appears that even dogs that make it through demanding training programs suffer from the aversive training methods.

Interventional studies

One study compared the application of shock to 3 groups of laboratory-bred Beagles (Schalke et al., 2007). The first group of dogs received the shock precisely when they grabbed a prey dummy. This led to an increase of ~22% and ~31% in absolute and relative salivary cortisol, respectively. The second group received the shock if they failed to respond to a recall while hunting the prey dummy (~114% and ~160% increase in absolute and relative salivary cortisol, respectively). The third group received arbitrary and unpredictable shocks (~336% and ~328% increase in absolute and relative salivary cortisol, respectively). The fact that the Beagles that were shocked unpredictably had extremely high cortisol levels is not surprising, as they could not predict and had no control over the coming shocks. In the second group, it is possible that the elevated levels of cortisol were due to the fact that the recall was trained without a prey dummy but was tested with it. Hence, it was difficult for the dogs to control their first reaction to chasing the prey. In the first group, the predictability of the shock could have led to the relatively small increase in cortisol levels, but another explanation is possible. Although an increase in the concentration of cortisol can represent an increase in stress (Dreschel and Granger, 2005), it can also represent the physical activity level of the dog. Indeed, elevation in cortisol concentration can occur as a result of both low-intensity and high-intensity exercise (Radosevich et al., 1989). However, the dogs in this study (Radosevich et al., 1989) exercised for 90 minutes on a treadmill, and although plasma cortisol gradually increased with the duration of exercise, large elevations were seen only after 15-30 minutes of exercise. Because the dogs in Schalke et al.'s (2007) study ran after prey for less than 2 minutes a day, and because plasma cortisol samples were taken 10 minutes after the administration of the shock, it is unlikely that the short exercise contributed significantly to the elevation in cortisol levels.

A second study (Cooper et al., 2014) compared the behavior and cortisol levels of dogs trained to come when called, in 3 training groups: (1) using an electronic collar, (2) training without an electronic collar but by the same trainers from group 1, and (3) training without an electronic collar by trainers who believe in reward-based training. The study found no differences in training effectiveness between groups. The dogs that were trained with electronic collars tended to spend more time in a tense state, carried their tails lower, interacted less with the environment, and yawned more compared to the dogs that were trained without the electronic collars by reward-based trainers. No differences in urinary cortisol levels were found between groups, but salivary cortisol levels were higher in the group trained by the reward-based trainers compared to the 2 other groups throughout the experiment. However, comparing the difference between post-training cortisol to pretraining cortisol revealed no differences between the 3 groups, suggesting that these values were not due to training methods.

Although the previous studies compared aversive and non-aversive training methods, the effects of 3 aversive training methods on learning as well as on possible unintended outcomes were examined in a study of 42 police dogs (Salgirli et al., 2012). The dogs were required to heel while a person serving as a decoy tried to distract them and cause them to leave the handler's side. In a counterbalanced design, the dogs received either a pull on a pinch collar, a shock from an electronic collar, or a quitting signal that was conditioned to signify the withdrawal of a reward. A similar number of dogs learned to disregard the distraction with the use of the electronic collar ($n = 39$) and the pinch collar ($n = 32$), compared to only 3 dogs with the use of a quitting signal. A plausible explanation for these results is that the dogs receiving the quitting signal did not understand what was expected of them in this specific setting. Indeed, the training of the quitting signal was done with a toy and not with a provoking person. Expecting the dogs to generalize the quitting signal with a toy to a different scenario seems unrealistic. Hence, it is not surprising that the quitting signal failed to elicit the required behavior.

Although not statistically significant, 64.3% ($N = 27$) of the dogs showed an extreme backwards ear position after being punished with the pinch collar, compared to 38.1% ($N = 16$) that were punished using the electronic collar. In addition, approximately 43% ($N \sim 18$) of the dogs being trained with a pinch collar or an electronic collar showed a lowering of their back, and approximately 31% ($N \sim 13$) of the dogs crouched. Vocalization was seen in approximately 60% of the dogs with the electronic collar ($N \sim 25$) compared to approximately 23% of the dogs with the pinch collar ($N \sim 10$) (exact values were not reported in the original study; values extracted from figures). Finally, of the 4 dogs that responded to the quitting signal, 2 showed a backward ear position and one showed an extreme lowering of body posture and crouching.

Unfortunately, cortisol levels are difficult to interpret in this study. This is because actual cortisol values and effect sizes were not reported and because there are contradictions in the reporting of results. For example, the authors state that no significant differences in relative cortisol levels were found between groups, but at the same time, they report that the relative cortisol level after the quitting signal was significantly higher than after the use of a pinch collar (Salgirli et al., 2012, p. 534). Still, 17 dogs showed maximal cortisol values with the quitting signal, 15 dogs showed maximal cortisol values with the electronic collar, and 10 with the pinch collar. Statistical significance was not reported for these values.

The results of this study suggest that the use of positive punishment in the form of a pinch collar or an electronic collar can have detrimental effects on dogs' physical and mental welfare. In addition, using negative punishment without clear or consistent instructions of what is expected of the dogs can lead to fear and stress.

Bark collars

Bark collars are a different type of electronic collars. Unlike regular electronic collars that are operated manually by the handler, these collars are designed to automatically deliver a shock every time a dog barks. One study (Steiss et al., 2007) compared the use of electronic bark collars, lemon spray collars (i.e., instead of an electronic shock, a spray of an unfavorable odor is sprayed during barking), and control (inactivated) collars. Dogs in both the electronic and spray collars groups barked less than dogs in the control group. Although no statistically significant elevation in plasma cortisol or in adrenocorticotropic hormone (ACTH) was reported in any of the groups (perhaps due to the small sample sizes), calculations of effect sizes portray a different picture. These calculations revealed an increase in plasma cortisol between the first day of wearing the activated collars and the acclimation stage to the collars (Cohen's $d = 1.3$ and 1.7 for the electronic collar and the spray collar, respectively). Similar effect sizes were calculated for ACTH (Cohen's $d = 0.82$ and 1.9 for the electronic collar and the spray collar, respectively). These effect sizes are considered large and represent significant elevations in plasma cortisol and ACTH as a result of wearing the activated collars.

The fact that bark collars can in some cases reduce barking was shown previously, in a study that compared the satisfaction of owners when using either an antibark citronella collar (88.9% satisfaction; N = 8) or an antibark electronic collar (44.4% satisfaction; N = 4) in a sample of 9 dogs (Juarbe-Diaz and Houpt, 1995). However, the more relevant question is not whether these bark collars work, but rather whether there are other effective training methods that can alleviate barking without the added stress that is associated with them.

In summary, except for 1 study (Blackwell et al., 2012), all of the observational and interventional studies reviewed suggest that the various types of electronic collars may pose risks to dogs' welfare. Indeed, Schilder and van der Borg (2004) showed the risks to dogs' welfare even when the collars are operated by experienced trainers. The fact that dogs associate shocks with the presence of handlers (probably due to classical conditioning) is not surprising and is troubling. It could be argued that the association these dogs make between their handlers and the painful shocks can make them less reliable in situations when faultless performance is most needed. This putative association should be examined in future studies.

The smallest elevations in cortisol levels when using electronic collars were reported when well-timed shocks were delivered in a controlled environment (Schalke et al., 2007). Although no data are available on this topic, it is unlikely that dog owners would have the necessary skills or experience to use such collars, nor would they operate the collars in a controlled environment.

Finally, shock collars, even in the hands of the most experienced trainers, can only provide information regarding what behavior not to perform. These devices do not give the dog a choice of an alternative behavior to perform. Hence, given the available data and to avoid risking the dogs' welfare, trainers should avoid using electronic collars when training dogs.

The effects of aversive training techniques on physical health

The psychological unintended outcomes of aversive training methods have been described, but the effect of aversive training methods on the physical health of dogs should also be examined. It appears that stress can be associated with aversive training methods. Increased cortisol levels followed shocks from electronic collars (Schalke et al., 2007) and were found in dogs with activated electronic and citronella bark collars (Steiss et al., 2007). Training inconsistency and the use of electronic or pinch collars were related to maximal cortisol levels (Salgirli et al., 2012). Importantly, Beerda et al. (1998) reported that unanticipated stimuli such as short electric shocks and sound blasts led to increased salivary cortisol in dogs. Low body posture, body shaking, crouching, yawning, and restlessness were also indicators of acute stress (Beerda et al., 1998). Finally, Dess et al. (1983) showed a marked elevation in mean cortisol with (258% increase) or without (400% increase) control over electronic shocks. Control over the situation was assessed by allowing or preventing the dogs from pushing a lever to stop the shock. In addition, elevations in mean cortisol were seen whether the dogs could have predicted (291% increase) or could not have predicted (374% increase) the coming shock (Dess et al., 1983). Predictability was introduced by presenting an auditory tone before the shock or shocking the dogs without signaling it beforehand.

Such stress can affect dogs' physical health. Indeed, a recent review of the effects of stress on animals' health suggests that stress is associated with various damaging changes to physical health in dogs, including suppression of the immune system, gastrointestinal problems (e.g., diarrhea, vomiting, decreased appetite), delayed puberty, and decreased sperm quality (Mills et al., 2014). The studies reviewed here examined acute stress responses, but it is mostly chronic stress that can negatively affect physical health in the long term (Beerda et al., 1997). One study found a relationship between dogs' fear of strangers—a possible powerful stressor, and a shortened lifespan (Dreschel, 2010). The chronic effect of stress due to aversive training on dogs' physical health should be a relevant topic for future research. More research is needed to clarify the relationship between dogs' behavior and stress because behavioral responses can vary between individual dogs and between various stimuli and can be misinterpreted.

It is also possible that using certain punitive techniques presents more direct health risks. One study showed increased intraocular pressure in dogs while pulling against a collar (Pauli et al., 2006). Importantly, 1 extreme case report of the effects of a specific punitive technique on the physical health of a 1-year-old German Shepherd dog was found (Grohmann et al., 2013). The dog was hung several feet in the air with a choke collar for approximately 60 seconds and subsequently lost consciousness. A few hours after this incident, the dog developed several neurological symptoms (ataxia in all 4 limbs, circling to the left, disorientation). Magnetic resonance imaging revealed severe cerebral edema due to ischemia. Tragically, the owner chose to euthanize the dog. Although this is an extreme case in the published literature, the author suggested that the punitive technique of choking a dog while hanging it in the air is not uncommon, and more cases such as this one may have gone unreported. Veterinarians and trainers should be made aware that hanging a dog in the air or "helicoptering" it (e.g., lifting up by the choke chain and circling the dog in the air) presents a severe threat to dogs' health and obviously should be avoided. Legislators would do well to make such practices illegal.

Discussion

The discussion is divided into 2 sections: (1) Methodological concerns and (2) Implications for practitioners and researchers.

Methodological concerns

This section discusses 4 methodological concerns regarding the reviewed literature.

Sample size and lack of the reporting of effect size

The reporting of effect sizes allows readers to assess the practical significance of group differences and is not related to sample sizes. This information is of importance because the lack of statistical significance does not necessarily mean that differences between groups are not of consequence. For example, in 1 of the reviewed studies (Steiss et al., 2007), calculation of effect sizes revealed relatively large differences in plasma cortisol, although those were not statistically significant. The lack of statistical significance was probably due to the small sample sizes (i.e., 6-8 dogs in each of 3 groups). Statistical analyses in future studies should make sure to report effect sizes in addition to null-hypothesis testing.

The reliance on surveys and observational data, and the ethics of randomized interventions

Many of the reviewed studies were based on surveys and observations. Although these studies are valuable, they do not allow researchers to assess causal relationships. Hence, performing randomized controlled interventions in which dogs are randomly assigned to punishment-based training groups versus reward-based training groups may be warranted. However, the results of this review, and the vast literature on punishment in general (e.g., Durrant and Ensom, 2012; Sidman, 2000), suggest that punishment comes with negative unintended outcomes that can be detrimental to an animal. From an ethical perspective, researchers should be cautious before performing such interventions and should ensure that the dogs' welfare is not threatened. Once these conditions are met, researchers can be encouraged to continue learning about the effects of aversive training methods on dogs' behavior and welfare within the realm of observational studies. Direct observations of larger sample sizes, with a robust methodology of coding the observed behaviors (e.g., using 2 observers who are blinded to the hypotheses, reporting interrater reliability), will allow researchers to provide enlightening data on this topic without endangering the dogs' welfare.

Reporting case studies on physical health risks due to aversive training methods

Only 1 study reported a severe case of brain damage, due to hanging a dog in the air with a choke chain as a punitive technique (Grohmann et al., 2013). Because the use of such aversive methods may still be prevalent, it is unlikely that this is the only case. In addition, many punitive techniques involve pressure on the neck, which may lead to dangerous increases in intraocular pressure (see Pauli et al., 2006). Veterinarians should be encouraged to publish case studies in which dogs were injured due to the use of aversive training methods. Publication of this type of information will allow those who work with dogs to understand the negative physical symptoms related to aversive training methods and perhaps reduce their occurrences.

The operation of electronic collars by experienced trainers

In all of the observational and interventional studies that reported the use of electronic collars, experienced trainers operated the collars. The results of the studies suggest that even when experienced trainers operate these collars, the welfare of the dogs could be compromised. However, most dogs are not owned by professional trainers, and the effects of regular pet owners using such collars on dogs' welfare are not known. Indeed, it is likely that the threat to dogs' welfare would be even greater in the hands of unskilled dog owners, who might lack the timing and consistency needed for this type of training to be successful. In such cases, due to the aversive nature of these devices and the likelihood of training ineffectiveness, their use can be abusive.

Implications for practitioners and researchers

Despite the methodological concerns, it appears that aversive training methods have undesirable unintended outcomes and that using them puts dogs' welfare at risk. In addition, there is no evidence to suggest that aversive training methods are more effective than reward-based training methods. At least 3 studies in this review suggest that the opposite might be true—in both pets and working dogs (Blackwell et al., 2012; Haverbeke et al., 2008; Hiby et al., 2004). Because this appears to be the case, it is recommended that the dog training community embrace reward-based training and avoid, as much as possible, training methods that include aversion. For this purpose, it is proposed that Friedman's (2009) hierarchy of intervention strategies may be a good tool for choosing the least intrusive, yet effective, behavior modification tools. Friedman (2009) lists 6 levels of intervention: (1) arranging distant antecedents (least intrusive); (2) arranging immediate antecedents; (3) positive reinforcement; (4) differential reinforcement of alternative behavior; (5) negative punishment, negative reinforcement, extinction; and (6) positive punishment (most intrusive). According to Friedman (2009), levels 1-4 are sufficient for solving the vast majority of behavior problems in animals. Level 5 may occasionally and under certain conditions be the effective and ethical choice. Level 6 is rarely needed or suggested when the practitioner has good teaching skills and the required knowledge of behavior. It may be noted that such ethical hierarchies of intervention that begin with the least intrusive and end with the most intrusive are practiced in children's education as well (Carter & Wheeler, 2005). As Friedman (2009) suggests, it may be wise to borrow such guidelines from the field of applied behavior analysis, as both animals and humans who require behavior modification are often vulnerable and frequently cannot protect themselves. If aversive or intrusive methods are chosen, the competence of the handlers is critical in order that they may achieve the proper timing and consistency required to allow for quick learning and to avoid abusing dogs and threatening their physical and mental well-being. Handlers' competence should be defined, regulated, and assessed by relevant regulating agencies based on the recommendations of accredited and experienced animal behaviorists.

One could rightly suggest that more studies with better methodologies concerning the effects of aversive training methods on dogs' welfare are needed to strengthen the evidence on this topic. However, the data emerging from the current review, as well as available data on the negative unintended outcomes of aversive training methods in other species, such as in humans (e.g., Durrant and Ensom, 2012; Sidman, 2000) and rats (e.g., Ulrich and Azrin, 1962), suggest that it is perhaps time to pursue a different focus and approach of research. This new line of research will examine how humane, reward-based methods can be improved to facilitate better communication between humans and dogs. In turn, such outcomes will allow dogs to modulate their stress and, at the same time, improve their ability to effectively understand and respond to the behavior displayed toward them.

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Conflict of interest

The author has no conflicts of interest relevant to the content of this review.

Ethical considerations

No ethical approval was required as this is a review of literature.

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