

Canine Aggression Toward Unfamiliar People and Dogs

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Dog aggression is a serious public health issue in the United States. More than 4 million dog bites to humans are estimated to occur each year [1], and up to 42% of dogs presented to behavior clinics do so for aggression toward other dogs [2]. Aggression places a serious strain on the human–animal bond. Dogs frequently are surrendered to shelters for behavioral reasons, including aggression [3]. Additionally, injuries to victims can result in owners' incurring significant financial and legal burdens. Although aggression is a normal behavior in all animal species, it becomes problematic when it develops in abnormal intensities or contexts, manifests toward aberrant targets (eg, is self-directed), becomes dangerous to other people and animals, and/or interferes with the human–animal bond.

DIAGNOSIS AND CLASSIFICATION

Different authors have classified aggressive behavior in various ways using either functional or categorical divisions. Common categorical terminology can facilitate professional communication; however, such a scheme does not accurately describe all patients—even humans (as evidenced by the number of “disorder unspecified” labels found in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*). In a reductionist sense, canine aggression towards unfamiliar people and dogs generally occurs because of fear, resource guarding (protection of territory, owners, or other animals), or predation. In many cases, dogs present with multiple forms of aggression.

Fear-motivated aggression is the most common diagnosis in dogs aggressive toward unfamiliar stimuli, even when elements of territoriality are present. Offensive posturing by the dog does not rule out anxiety or fear as an underlying cause [4]. The distance to the stimulus and previous learning affect the dog's behavioral presentation. Many dogs show highly offensive posturing when behind a barrier or when the trigger stimulus is far away. As the stimulus approaches or the barrier is removed, the dog's behavior may become more ambiguous and finally reflect outright fear. It is common for dogs to be highly

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reactive or aggressive toward other dogs while on leash but then to interact appropriately while off leash. Several theories are postulated to explain this behavior. First, the dog may feel trapped by the confines of the leash, which limits the dog's movements, including its ability to retreat. Second, a tight leash (especially if the owner also is pulling actively) while the dog is approaching or greeting another dog may alter the dog's posture sufficiently to send misleading signals. These signals may trigger the recipient dog to react agonistically, with a scuffle ensuing. Over time, the dog learns that on-leash greetings are unpredictable and potentially dangerous, and the dog becomes preemptively defensive. Third, excitable, but friendly, dogs often are punished with leash corrections for overly exuberant behavior around other dogs. Again, over time the dog learns that the approach of other dogs predicts unpleasant and potentially painful circumstances, generating defensive behavior.

Territorial behavior manifests primarily in the dog's home and yard but also may occur in the car or in areas where the dog is walked habitually. Territorial behavior tends to be most intense directly along the boundary line, and dogs may protect small territories more intensely than large ones [5]. Unlike fear aggression, which often manifests at an early age, territorial and protective behavior are not expected to occur until 6 months of age or older, when the dog approaches social maturity [6]; however, these latter types of aggression frequently have elements of fear as well.

Dogs showing apparent protective behavior more commonly are fear aggressive but become more offensive in the presence of their owner. It is speculated that this change occurs because the owner may have reinforced the dog inadvertently or, alternatively, has punished the dog in the presence of strangers or other dogs, intensifying the dog's emotional reaction to the stimulus. Dominance-related aggression typically is directed toward dogs with which the dog has frequent close, social contact. On occasion, however, dogs do seem to engage in status conflicts with strange people and, more commonly, with unfamiliar dogs. This behavior occurs in relatively close proximity to the stimulus, where postural signaling is most effective; thus dominance probably is not the diagnosis if the dog shows aggressive behavior toward the stimulus from a distance. Predatory reactions are more likely to be directed toward small dogs and fast-moving objects such as joggers and cyclists [7].

ETIOLOGY AND DEVELOPMENT

The development of aggressive behavior frequently is complicated and multifactorial. Problems associated with aggression in dogs fall into two broad categories: (1) normal dogs expressing normal but unacceptable behavior or (2) abnormal dogs reacting out of context to the environment [8]. The boundaries of "normal" behavior are not fixed rigidly: perinatal factors (intrauterine environment, maternal and sibling interactions), experience (socialization and learning), and biologic correlates (genetics, hormones, and neurophysiologic factors) all affect the expression of the behavior.

Genetics and Breed Influences

Selection of phenotypic and behavioral characteristics in dog breeds has resulted in various changes in social competency. Some breeds do show tendencies toward certain forms of aggression [4,9]. Behavioral traits, including aggression, have been identified as clustering in lines or families within a breed [10] or even to be related to coat color patterns [11]. The heritability of owner impressions of aggressive behavior toward dogs and humans in Golden Retrievers has been estimated as high as 81% [12]. A group of studies by Svartberg [13,14] identified consistent heritability of a boldness/shyness personality factor in dogs. Genetics also influences behavior through effects on neurotransmitter systems and other biologic correlates.

Biological Correlates of Aggression

Hormones and gonadectomy

A vast body of literature has examined the effects of sex steroids, particularly testosterone, on aggression in various species. Although testosterone does influence the expression of aggressive behavior, there is a complex interplay between testosterone, social status, neurotransmitters systems, gender, and environmental context [15]. Castration of male dogs affects sexually dimorphic behaviors and will reduce mounting, urine marking, and roaming. Reductions in territoriality and aggression toward other dogs (particularly other males) occurs, but to a lesser degree [9,16,17]. Ovariohysterectomy in females does not influence aggressive behavior significantly or consistently [18]. Kim and colleagues [19] evaluated seven intact and seven ovariohysterectomized German Shepherd bitches for reactivity and aggression and found that 5 months after spaying the spayed bitches showed significantly more reactivity than intact bitches. Gonadectomy should not be expected to play a major role in controlling aggression in dogs.

Neurotransmitters and neural correlates

The biologic basis of aggression is complex. Studies of violence and aggression in humans have focused heavily on the neurotransmitter serotonin (5-HT). The 5-HT system is associated with behavioral inhibition [20]. Evidence links 5-HT deficiency to aggression, but this effect is difficult to isolate from its effects on impulsivity and social behavior, because serotonin also tends to improve both these traits [21]. Reisner and colleagues [22] found lower levels of the serotonin metabolite 5-HIAA in the cerebrospinal fluid of dominant aggressive dogs than in nonaggressive dogs. Other studies of aggressive dogs also have found differences in serotonin receptor densities and function in various brain regions [23]. Biologic correlates may be particularly relevant for the classically “reactive” dog. These dogs respond to even mild or apparently nonthreatening stimuli in a volatile manner, and this reaction may be intensified if the stimulus appears suddenly. Intermittent explosive disorder (IED) in humans may serve as a model for such dogs. Human patients who have IED are defined by impulsive aggressive behavior and are highly reactive to even low-level provocation. These patients rate higher on general anger and hostility than do groups with other

psychiatric diagnoses [24]. Patients who have IED also are impaired in their recognition of some facial signals [25], which can affect their social proficiency. Dogs have been shown to have reduced competency in social signaling compared with wolves [18]. Perhaps dogs have deficits in signal interpretation contributing to the comparatively higher level of aggression in dogs than in wolves.

The limbic system, chiefly the amygdala, processes threat and emotional responses. As part of the temporal lobe, the amygdala has a low seizure threshold. Partial seizures in the temporal lobe can trigger feelings of fear, anxiety, irritability, and anger. If a hypersensitivity develops in the amygdala so that a subseizure threshold of neuronal excitability exists, emotional disturbances could arise. This possibility is supported by the fact that human patients who have this behavioral and emotional profile improve when taking anticonvulsant medication [26]. A hyperresponsive amygdala easily could describe the “reactive” dog mentioned previously. Essentially, the amygdala sends a high rate of false alarms that activate the fight–flight system and the regions of the brain responsible for vigilance, attention, anxiety, and fear. Some support for this conjecture comes from studies by Jacobs and colleagues [27] showing that aggressive dogs have higher basolateral nucleus group volumes and neuronal densities in the amygdala than do nonaggressive dogs. Basolateral nucleus groups of aggressive dogs also were shown to have more neurons containing neurokinin 1, which is involved in regulation of aggressive behavior [28]. Furthermore, there are dense concentrations of 5-HT receptors in the amygdala. Serotonin has a net inhibitory effect in the amygdala, so 5-HT-deficient states would result in compromised braking of amygdalar reactions [26].

Perinatal environment and early experience

A puppy’s perinatal environment can have a lasting impact on its adult behavior. Maternal stress or early postnatal stress can permanently alter an animal’s reactivity to future stress [29,30]. Studies indicate that low-level postnatal stress (brief maternal separation and neonate handling) is protective. It reduces hypothalamic-pituitary-adrenal (HPA) reactivity and increases hippocampal 5-HT. In contrast, more severe stress (prenatal stress, prolonged maternal separation, perinatal illness) can increase the HPA axis responsiveness to physiologic and psychologic insults in the future [29,31]. Therefore, breeders should be counseled carefully on the perinatal environment of their litters.

Socialization deficits are arguably the most prominent factor in the development of aggression in physiologically normal dogs. Unfortunately, the amount of socialization required for optimal development of any individual is unknown. Roll and Unshelm [32] noted that 44% of a population of dog-aggressive dogs had few or no interactions with conspecifics from 5 weeks to 5 months of age. Deficits in social interaction may become more problematic as the animal matures and neophobia and competitive interactions become more salient. Mere exposure to other people and dogs is not sufficient to guarantee adequate social skills. Interactions must be monitored to ensure that the puppy has a positive and enriching experience.

Influence of learning

All forms of aggression are modified by learning. Aggression is about local control of the environment. If an animal learns that aggression will alter the environment in a desirable way, reinforcement occurs, and the animal will show that behavior pattern in a similar circumstance in the future. The power of reinforcement emphasizes the importance of avoiding trigger situations during management and treatment. See the article by Horwitz in this issue for further details.

TREATMENT

In dogs, the origin and progression of aggression to unfamiliar stimuli can vary, as can the associated behavioral presentation. Selecting the most appropriate treatment course depends on the animal's behavioral phenotype and the owner's resources and capabilities. Clinicians should explain each step of the treatment process carefully. Techniques should be demonstrated when appropriate and feasible. Owners must understand that altering the dog's behavior will take time, and improvement may not occur in a linear fashion. Although most owners do not want a lesson in neurophysiology, a brief and simple explanation of the persistence of neural circuits, particularly those associated with fear-related behaviors, can help owners understand their dog's behavioral responses. Setbacks are a typical part of most therapy programs, although the program should be designed and modified periodically to minimize them.

For some owners, the number of environmental changes and interventions can be overwhelming. Breaking the interventions down into progressions will help owners accomplish goals successfully and see more rapid response. This early positive reinforcement for the owner can improve compliance greatly. Treatment programs can be divided into three phases: management, foundation exercises, and stimulus-specific behavior modification exercises.

Management

Environmental management involves addressing the animal's biologic needs and preventing further rehearsal of inappropriate behavior patterns. Safety precautions also must be implemented.

Exercise and enrichment

Many dogs live in environments either grossly deficient in stimulation or replete with inappropriate stimulation. Additionally, as a dog's behavior becomes more problematic, the dog tends to be even more isolated from the environment. Many owners cease walking their dogs altogether, and dogs with territorial behavior often are relegated to spending large amounts of time crated or penned outside. The profound lack of mental and physical exercise compounds the dog's frustration and agitation and decreases the latency to arousal around triggering stimuli. Owners must find ways to exercise their dogs safely. They must walk the dog at times and in places where they are unlikely to encounter other people or dogs, even if the owner must drive the dog to an acceptable area. As well as burning off excess energy, exercise may help by elevating levels

of norepinephrine and 5-HT in the brain and releasing endogenous endorphins [33], the latter two of which have calming and anxiolytic effects [34,35]. Dogs ideally should receive at least 30 continuous minutes of aerobic exercise per day, because research indicates that prolonged aerobic exercise is more effective in triggering opioid-mediated effects on mood and sympathetic activity [36,37].

Mental stimulation through environmental enrichment helps occupy dogs that have limited physical exercise routines and that are left alone for long periods. Enrichment increases behavioral adaptation [31], in part by improving the animal's problem-solving skills. Rotating toys, feeding from food-dispensing devices, and engaging the dog in activities requiring problem solving (eg, training and discrimination tasks) all should be part of the dog's normal routine. Training even simple tricks is excellent mental stimulation and helps strengthen the dog-owner bond as well as increasing the dog's skill set.

Preventing inappropriate behavior

Dogs that have a long-standing history of aggressive behavior have developed a learned, conditioned reaction to trigger stimuli. Accordingly, owners also have become conditioned to anticipate unpleasant encounters. Most aggressive outbursts occur repeatedly in a handful of contexts such that these environments alone can predict the appearance of unfamiliar dogs and people. When the dog and the owner are exposed to these environments, both undergo anticipatory changes in autonomic arousal that push the dog closer to the reactive threshold even in the absence of triggering stimuli [38]. Temporarily removing the dog from these contexts (and from exposure to triggering stimuli) will facilitate the conditioning of more desirable behavioral responses. Avoidance also reduces the risk of injury to other people and dogs. The dog should not be exposed to any such stimuli until later in the rehabilitation process and only during controlled training sessions. For dogs that are aggressive when away from home, exercise modalities and locations must be altered, or the dog must be kept beyond its threshold distance for the stimulus. If the dog is aggressive inside the car, car rides should be minimized or stopped altogether. Some dogs are less reactive if crated while in the car, and the crate can be covered to prevent the dog from seeing stimuli outside. Similarly, inside the house, the dog should be prevented from patrolling windows and doors for passing people or dogs by blocking windows (eg, closing blinds) or gating the dog away from the front of house, especially in the owner's absence. If necessary, the dog can be crated or closed into a room with no or few windows and protected from outside noises. While the owner is home, the dog can be handled more safely and will respond more reliably if fitted with a head collar and dragline, which can be used to interrupt inappropriate behavior immediately but calmly. When visitors arrive, the dog should be confined before the visitor actually enters the house, ideally in an area where the dog cannot see the doorway through which the visitor arrives. If the dog is aggressive only as the visitor enters, but not afterward, the dog can be allowed out of

confinement, under supervision, and on leash with a head collar, once the dog is quiet and the visitor is settled.

Management tools

Helping the owner gain some sense of control over the dog is a valuable step early in a behavior program. Muzzle-loop head collars such as the Gentle Leader (Premier Pet Products, Inc., Richmond, Virginia) (Fig. 1) are especially advantageous for large and/or aggressive dogs. These collars provide excellent control over the dog's head, thereby allowing the owner to manipulate the direction of the dog's focus. Additionally, the owner can close the dog's mouth gently but firmly, which will prevent a bite in an emergency situation and allow humane correction of inappropriate behavior.

Dogs with a previous bite history, with severe or escalating aggression, and/or with owners that have difficulty controlling them should be trained to wear a muzzle. The muzzle must allow the dog to pant and accept food treats. Provided the dog cannot separate its canine teeth enough to grip another person or dog, a nylon sleeve muzzle can be used as effectively as a basket muzzle. If the muzzle is to be left on for long periods of time, the basket muzzle may be the preferable choice. Both types of muzzles limit panting, and care must be taken when they are used in hot weather. The dog must be adapted to both head collars and muzzles gradually in a manner that associates the devices with pleasant experiences. Neither piece of equipment should ever be placed on the dog as a form of punishment.

Not all dogs can wear a muzzle or head collar because of behavioral, medical, or conformational limitations. Other collar types and harnesses (eg, Easy Walk, Premier Pet Products, Inc.; Zuba Dream Walker, Zuba Pets, Menlo Park, California) are available that may improve the owner's control. Punitive collars such as a prong, slip chain, or electronic stimulation should be avoided. Punitive actions that elevate fear and/or cause the dog pain may be associated



Fig. 1. The Gentle Leader head collar (Premier Pet Products, Inc., Richmond, Virginia).

with the trigger stimulus rather than with the dog's own behavior [39]. This misdirected association is particularly likely if the owner has poor timing and mechanical skills, because the dog will be unable to associate the correction consistently with a specific behavior. This unpredictable punishment actually will increase the dog's anxiety level.

Dogs should be handled on a 4- or 6-foot nylon or leather leash. Retractable leashes are inappropriate and dangerous, because they provide poor control and can cause injury to the owner or the dog if the cord becomes wrapped around part of the body. Cotton long lines can be used to control the dog for exercise purposes, because aggressive dogs should never be off leash in public.

Dogs that are visually reactive may benefit by reducing the clarity of their visual field. The Calming Cap (Premier Pet Products, Inc.) is an elastic, semi-transparent cloth "hood" that covers the dog's eyes. This device can be extremely useful during car rides and also can be used in the home or on walks. TTtouch body wraps (Linda Tellington-Jones, Santa Fe, New Mexico) and the Anxiety Wrap (Animals Plus, Huntington, Indiana) have proven effective in calming some excitable or anxious dogs, although no studies have evaluated them in a controlled manner. These products provide tactile pressure over the dog's body for a swaddling or acupressure effect.

Dealing with unplanned exposures

One goal of good management is to reduce uncontrolled stimulus exposures; however, unexpected contacts do occur even with highly dedicated and attentive owners. Owners may carry a pop-open umbrella or Direct Stop citronella spray (Premier Pet Products, Inc.) for dealing with free-ranging dogs. Some dogs can be discouraged with a firm, "No! Go home!" and others may be distracted by throwing a large handful of treats directly at the dog. Well-meaning people should be directed gently but firmly to avoid approaching the dog. Training the dog in advance to perform an emergency U-turn allows calm but rapid escape from a potentially volatile situation. The muzzle-loop head collars permit the owner to control the dog's head and mouth to prevent a bite (to the target or the owner if the dog is prone to redirect) without the need for punitive measures should another person or dog approach too closely.

In a number of cases, alterations in diet and exercise (mental and physical) and reduced exposure to provocative situations improve a dog's behavior sufficiently that the owner is content with management alone. This strategy is a viable one, particularly for time-restricted owners of dog-aggressive dogs, when avoiding contact with other dogs is relatively easy.

Foundation Exercises

The second level of intervention focuses on training foundation exercises, which increase the dog's skill set and give the dog alternative ways to respond to stimuli. The exercises also are designed to amplify the owner's general control over the dog and to improve the dog's focus on and responsiveness to the owner.

Basic cue response

Although many dogs previously were enrolled in a puppy or basic obedience class, an amazingly large number of owners have never sought any type of training for their dogs, even for dogs that have serious behavior issues. Few dogs with aggressive behavior are sufficiently proficient at even basic obedience behaviors. Although obedience itself will not resolve an aggression problem, these cues are important as a way for an owner to request alternative responses from the dog [40]. In situations where the dog is uncertain as to the most appropriate behavioral response, basic behaviors can provide the dog with clarity and safety if the behaviors have been trained previously and practiced in a clear and consistent manner. The goal of training is twofold: (1) to obtain reliable response to the cues, and (2) to condition the dog to become calm and relaxed when performing the behaviors. The latter is crucial and is done by rewarding the dog only for relaxed responses once the dog has a basic understanding of the behavior itself. At a minimum the dog should be able to respond to cues for “sit,” “down,” “stay,” and “come.” The dog should be able to walk calmly on leash by the owner’s side and also respond to its name by orienting to the owner. Targeting exercises (eg, the dog touching its nose to a target stick or the owner’s hand) also are valuable. These behaviors are easy to teach and are easy for the dog to learn, typically resulting in highly reliable behavior. Among other things, targeting can be used to reorient a distracted dog and to lead or lure the dog away from a problematic situation.

All behaviors should be trained using positive reinforcement. Positive reinforcement training establishes a classically conditioned positive emotional response (a “pleasure” feeling) to both the cue and the performance of the behavior. Training based on punishment may be associated with higher levels of behavior problems [41]. The addition of a bridge signal or conditioned reinforcer (eg, clicker, whistle) improves reinforcement clarity and can be used in future exercises as discussed later.

Establishing owner-focused interactions

Leadership programs frequently are recommended to establish command-response interactions between the dog and the owner and stress the importance of interacting with the dog only when the dog is calm. The owner begins to establish consistent behavioral criteria for any interaction with the dog (ie, petting, feeding, starting a training session, putting on the dog’s collar, opening doorways). Although it is most important that family members participate in these rules, visitors and other unfamiliar people are encouraged to abide by the protocol as well. Four basic criteria are required of the dog. These criteria can be introduced singly or together, depending on the dog’s baseline behavior and the owner’s skill:

1. Respond to any requested cue behavior (eg, sit) within an established time frame.
2. Remain calm during the entire interaction.
3. Remain focused on the owner during the interaction. The dog is encouraged to make eye contact and look to the owner rather than focusing on another resource or target.

4. Remain outside a previously designated “personal space” around the owner. This behavior keeps the dog from crowding the owner (eg, to get through a doorway) and also reduces nuisance behaviors such as jumping and mouthing.

The criteria for focus and calmness are by far the most important of the four. In all situations, if the dog fails to maintain an established criterion throughout the interaction, the owner aborts the interaction and directs the dog again. No verbal or physical punishment is applied. Once the dog has attained criterion again, the interaction can resume or start over.

Relaxation Tasks and Safety Cues

Relaxation tasks

Owners of aggressive dogs frequently state that the dog becomes so aroused that the dog is unresponsive in the presence of the triggering stimulus. Owners frequently try to calm or reprimand the dog to halt the aggressive reaction. The flaw in this approach is that such dogs lack emotional control and generally do not know how to relax and self-regulate their arousal, even on a daily basis. Therefore the owner’s attempts to calm the dog will be futile. In fact, the owner’s mounting tension and frustration typically raises the dog’s arousal even further. Relaxation must be taught to the dog in a methodical manner in an environment initially free of distraction.

Structured down-stay (or sit-stay) exercises should be practiced as a baseline relaxation task [42]. The dog is trained to maintain a short, relaxed down-stay and then gradually is exposed to increasing levels of generic environmental distractions and human activities. To further increase the dog’s baseline relaxation, behaviors that a dog exhibits voluntarily when normally relaxed can be reinforced and placed on cue. Because the dog already is inclined to perform these behaviors, they are relatively easy to put under stimulus control. Canine massage and TTTouch also are excellent exercises to establish changes in relaxation in association with a safety signal. Voluntary lateral recumbency is associated with relaxation in dogs. This “play dead” behavior (Fig. 2) can be placed on cue to allow the owner another tool for lowering arousal in the face of a provocative stimulus. Because this position is highly vulnerable for the dog, it is imperative that the dog never be physically forced into this position, either during the training phase or during a real situation. If the dog will not perform the behavior when cued, the behavior either is not sufficiently rehearsed or the dog has been placed in a situation that is too stressful for its stage of training. Forcing the dog into this position will seriously erode the dog’s trust in the handler (Relaxation tasks should serve as another form of safety signal.) The effectiveness of these behaviors can be enhanced by augmenting them with other safety signals such as conditioned odors or having the dog perform them on a “relaxation rug,” which can be transported to various locations.

All exercises are trained first within the owner’s home in a quiet environment. Once the dog is proficient, the tasks are repeated in other areas both on and off the owner’s property. The dog never should be asked to perform



Fig. 2. The lateral recumbency (“play dead”) position is used as a relaxation task. This dog has learned to perform this behavior reliably even in the presence of some fear-inducing distractions, and obeying this command helps control her arousal. Relaxation is shaped during the training of the behavior; however, note the tucking of the dog’s tail and the slight flexion of the right hind leg up toward the dog’s body. These signs indicate that shaping for further relaxation is needed.

in an environment that it is not yet ready to handle. Asking the dog to hold a relaxation position when it is in a stressful environment will erode the value of the behavior as a safety cue.

Safety cues and signals

Animals readily make associations between contextual (environmental) stimuli and emotional experiences that occur when those stimuli are present. For example, a dog in a veterinary examination room receiving a painful injection while resting on a blue rug may become afraid of blue rugs. Even though the rug was neutral and did not harm the dog, the rug became associated with the context in which the dog was hurt or frightened. Through a similar learning process, a dog can associate environmental stimuli with pleasant, safe experiences.

Safety signals are environmental stimuli that become paired with relaxed physiologic states in safe environments. Safety signals can be tactile, olfactory, visual, or auditory. They also can be previously trained behaviors (cues). The stimuli themselves eventually generate a relaxed state in the dog when the animal is exposed to them. Exercises addressing stimulus-specific responses revolve primarily around classical conditioning paradigms such as counterconditioning. Classical conditioning is a powerful tool for establishing baseline changes in physiologic and psychologic relaxation and in establishing the safety signals used during the last phase of training.

Conditioning safety cues involves choosing a specific stimulus (eg, a specific dog bed, small rug, or odor) and pairing its presence with pleasant activities and the relaxation tasks. For instance, the dog can be cued to lie on the dog

bed and then rewarded when it does so in a relaxed manner. During the conditioning process, the dog is never asked to lie on the bed when it is agitated, as a punishment, or while anything unpleasant to the dog (eg, nail trimming) is being performed. With repetitions the dog becomes conditioned to relax when asked to lie on the bed or when other safety cues are present.

Safety cues should be portable and easy to reproduce but also fairly unique to the environment in which they eventually will be used (eg, out on walks, at the veterinary clinic, when visitors come to the house). This specificity prevents the dog from habituating to their presence in the environment. The dog should be exposed to the safety signal only during conditioning sessions to ensure that the pairing of cue and relaxation remains as consistent as possible.

Stimulus-Specific Behavior Modification Exercises

Stimulus-specific exercises center on desensitization-counterconditioning (DCC) drills. Typical methodology has both classical and operant conditioning components, although variations may focus heavily on one element over the other. In traditional DCC, the animal is exposed to a low-level stimulus, and the presence of the stimulus is paired with something the dog finds rewarding, such as food or play. The previously described down-stay relaxation task serves as the foundation for stimulus-specific DCC. The trigger stimulus becomes a new distraction added to the protocol. The dog is asked to sit or down-stay, preferably in the presence of a previously established safety signal, and then the dog is exposed to a low-level stimulus (eg, a dog or person) at a distance such that the dog briefly alerts but then returns focus to the owner. If the dog reacts to the stimulus, the stimulus is too close or too intense. The dog then is rewarded for remaining calm in the cued position.

For each stimulus category (eg, dogs or people), the owner should develop a hierarchical list with the stimulus composition least likely to arouse the dog at the top and the stimulus composition most likely to trigger arousal at the bottom. The more intermediary stimuli listed, the better. The owner also should determine the thresholds at which the dog (1) alerts/orients to the stimulus, (2) barks/growls, and (3) lunges or tries to bite. This list becomes the dog's general training syllabus.

DCC sessions are divided into four base criteria: distance (between the dog and the trigger stimulus), duration (that the dog is exposed to the stimulus during any one trial), intensity (of the behavior or physical characteristics of the stimulus), and number (of stimuli present at one time during the trial). During any one trial, only one criterion should be manipulated. For example, if an owner finishes a trial with a child 30 feet away from the dog, on the next trial the child should not move closer to the dog and change his/her behavior. Rather, the child either should be asked to move closer or to alter his/her behavior. Once the dog can master each criterion individually, sessions can begin to incorporate multiple criteria at one time.

Highly aroused dogs may benefit from beginning DCC with audiotapes of sounds associated with the trigger stimulus (eg, dog tags, barking, footsteps on the sidewalk, human voices). This technique allows the owner to begin the process in the safety of the dog's home. For dogs with territorial aggression, sessions should include sounds of doorbells and knocking. The dog also should be trained to sit or lie calmly away from the door when the door is opened and someone enters. This behavior is accomplished first with family members, then with familiar visitors, and finally progresses to unfamiliar visitors.

Some dogs are so reactive that any visual exposure results in a dramatic aggressive display even if the stimulus is hundreds of yards away. For these dogs, a purely classical conditioning paradigm using a previously conditioned bridge stimulus (ie, clicker or whistle) may be more appropriate initially. The dog is placed in a sit-stay position and is controlled by a head collar. The stimulus (eg, a person) steps into view from behind a solid barrier at a great distance for only 1 or 2 seconds before stepping back behind the barrier. (This brief appearance reduces the likelihood that the dog's arousal will continue to escalate.) As the person comes into view, the owner immediately applies the bridge stimulus, irrespective of the dog's behavior, and then offers the dog food or a toy. The dog may be so aroused by the sight of the person that it refuses the food. In the absence of the bridge signal, this level of arousal means conditioning may not occur, because the dog may refuse the food or toy. The bridge signal allows the beginning of conditioning even if the dog refuses to eat the food or play with the toy. The dog is allowed to return to baseline arousal before the process is repeated. Over time, this method can establish an "auto-look" to the owner after the person comes into view. This looking to the owner is the beginning of a threshold, in that there is a brief period of non-reaction. At this point traditional DCC can begin.

Diet and Nutrition

There is considerable controversy and conflicting data on the influence of dietary factors on aggressive behavior. Few controlled studies have evaluated nutritional effects in dogs. Dodman and colleagues [43] evaluated the influence of dietary protein level on aggressive behavior and found that reductions in protein may help reduce territorial behavior associated with fear, but the effect was not robust, and the diet did not affect other types of aggression studied. Studies in humans have shown changes in aggression and violence with dietary tryptophan supplementation [44] and one study indicated a possible effect in dogs [45]. Anecdotal reports indicate possible benefits of raw food diets, grain-free diets, and low-protein diets; however, no controlled studies have been done with the former two diets. How any individual animal responds to dietary change is unknown and seems to be a matter of trial and error. Gesch and colleagues [46] noted improvements in violence and antisocial behavior in prisoners receiving a supplemental vitamin-mineral and fatty acid preparation. Similar results might be obtainable in dogs.

Pheromone and Aromatherapy

The canine olfactory system is well developed and represents a significant portion of the dog's brain mass. The olfactory system is highly connected to the limbic system. Dogs have a functional vomeronasal organ that transmits information to the accessory olfactory bulb and then on to the amygdala [47]. Olfactory stimuli can play a substantial role in the development and resolution of behavior issues. Dog-appeasing pheromone (DAP; Ceva Santé Animale, Libourne, Gironde, France) is a synthetic analogue of the pheromone secreted by lactating bitches. Recent studies have shown merit in its use for increasing adaptability in newly adopted puppies [48], for improving performance in puppies attending puppy classes [49], for reducing signs of fear or anxiety in veterinary settings [50], and for treating fear of fireworks [51]. Wells [52] has demonstrated that lavender scent can reduce excitability during car rides, and it also increases relaxation in shelter settings [53]. Lavender can be used spontaneously or conditioned as a safety cue to be used in the home or applied to a bandana the dog wears while away from home.

Pharmacologic Intervention

Currently there are no medications labeled for treating aggression disorders in dogs. There are few controlled clinical studies evaluating drug therapy in aggressive dogs. Virga and colleagues [54] found no benefit with amitriptyline use in aggressive dogs as compared with behavior modification alone. White and colleagues [55] also found no effect beyond placebo in the use of clomipramine for dominance-related aggression. One study evaluating the use of fluoxetine in dogs with dominance-related aggression did find a small effect, but the improvement also could be attributed to placebo effects [56].

Despite the lack of data supporting clinical efficacy, anecdotal reports indicate that pharmacologic intervention can facilitate or expedite behavior therapy in some cases. Benefit may be most likely if (1) the aggression is related to high-anxiety states or fearful behavior, (2) the animal appears to have a concurrent impulse-control disorder, or (3) the dog is truly "reactive," that is, the behavioral profile supports the possibility of amygdalar hyperreactivity.

Selective serotonin reuptake inhibitors (SSRIs) manipulate serotonin concentration in the synaptic cleft, and their effect is relatively specific for serotonin. They have antidepressant, anxiolytic, and anticompulsive effects [57]. SSRIs currently are the primary class prescribed for aggression problems in dogs (Table 1). Fluoxetine, recently approved for use in dogs for separation anxiety under the name Reconcile (Eli Lilly, Indianapolis, Indiana), is the SSRI with the longest history of use for behavior problems in dogs. Its use for aggression is extra-label. All SSRIs require continuous prolonged administration to produce therapeutic changes. Fluoxetine typically is well tolerated; however, reported side effects include sedation, gastrointestinal upset, anorexia, irritability, agitation, and seizures [58]. Fluoxetine and paroxetine [59] inhibit various cytochrome P-450 enzymes; therefore, potential drug interactions should be monitored carefully. Other commonly used SSRIs include paroxetine,

Table 1

Dosages for common psychotherapeutic agents in dogs

Drug	Dosage	Reference
Azaspiron		
Buspirone	1.0–2 mg/kg every 8–12 hours	
Anticonvulsants		
Carbamazepine	4–8 mg/kg every 12 hours	
Gabapentin	10–30 mg/kg every 8–12 hours	Plumb [66]
Beta-blockers		
Pindolol	0.125–0.25 mg/kg every 12–24 hours	Plumb [66]
Propranolol	5–40 mg/dog every 8 hours	Plumb [66]
Benzodiazepine		
Alprazolam	0.02–0.1 mg/kg every 8–12 hours	
Clorazepate	2 mg/kg every 12 hours	
Diazepam	0.55–2.2 mg/kg every 8–12 hours	
Selective serotonin reuptake inhibitors		
Citalopram	0.5–1.0 mg/kg every 24 hrs	
Fluoxetine	1.0–2.0 mg/kg every 24 hours	
Paroxetine	0.5–1.5 mg/kg every 24 hours	
Sertraline	0.5–4.0 mg/kg every 24 hours	
Tricyclic antidepressants		
Amitriptyline	1.0–4.0 mg/kg every 12 hours	
Clomipramine	1.0–3.0 mg/kg every 12 hours	

Data from Crowell-Davis SL, Murray T, Seibert LM. Veterinary psychopharmacology. Ames (IA): Blackwell Publishing; 2006; and Simpson BS, Papich MG. Pharmacologic management in veterinary behavioral medicine. *Vet Clin North Am Small Anim Pract* 2003;33(2):365–404, unless otherwise noted.

sertraline, fluvoxamine, and citalopram. Sertraline and fluoxetine often are useful choices for older dogs because they do not have the anticholinergic effects of paroxetine that may interfere with cognitive function [60].

Tricyclic antidepressants (TCAs) also have a long history of use for behavior problems in dogs. Amitriptyline and clomipramine (labeled for separation anxiety in dogs under the name Clomicalm [Novartis Animal Health, Greensboro, North Carolina]) are the two most frequently prescribed. These drugs have both serotonin and norepinephrine reuptake properties, with clomipramine being more specific for serotonin [60]. TCAs also have anticholinergic, antihistaminic, and alpha-adrenergic blockade effects, which are responsible for most of the observed side effects and can include sedation, constipation, urinary retention, vomiting, diarrhea, agitation, hypotension, and lowered seizure threshold [61].

TCAs seem to be more effective for anxiety- and fear-related disorders. Given the lack of therapeutic effect in the few studies evaluating TCAs for aggression, it might be wiser to reserve these drugs for use in dogs that have concurrent severe anxiety disorders or in cases in which SSRIs have failed to produce any therapeutic response.

Although not commonly used, anticonvulsants such as carbamazepine or gabapentin may have some utility in dogs that seem to have amygdalar

hyperreactivity [58]. These drugs sometimes are used in conjunction with SSRIs to control explosive aggression. Buspirone, an azaspirone, is a presynaptic 5-HT_{1A} agonist. It also has partial agonist properties at postsynaptic 5-HT_{1A} receptors. Buspirone has been used to control mild anxiety disorders and generalized anxiety [58]. Its effect on aggressive behavior has not been evaluated, but clinical experience indicates that as a sole therapy it has little role in controlling aggression in dogs.

Serotonin modulators, discussed previously, all require continuous administration for therapeutic effects. Some drugs can be used on a situational basis to control anxiety and frustration that may contribute to aggressive responses. These medications can be given on an as-needed basis, for example, before outings during which avoidance of problematic stimuli is impossible or to enhance success during a controlled training situation. Situational drugs include opioids, beta-blockers, and benzodiazepines. As mentioned previously, opioids can modulate serotonergic transmission and sympathetic activation, thereby reducing heart rate, blood pressure, and anxiety [36]. Similarly beta-blockers have been postulated to reduce anxiety by controlling heart rate changes associated with anxiety, although some beta-blockers (eg, pindolol) have direct serotonergic actions as well. Benzodiazepines are very effective for reducing anxiety, but they also may produce disinhibition of aggression [62,63], particularly in an animal that is highly offensive. Therefore, their use probably should be restricted to animals whose aggression is purely defensive.

There also is little evidence that most natural therapeutics are useful in the treatment of aggression, except for tryptophan, as mentioned earlier, and a milk hydrolyzate, alpha-casozepine, which seems to be beneficial in reducing some forms of anxiety [64]. Crowell-Davis and colleagues [65] provide a more detailed review of medications and their usage in veterinary psychopharmacology.

SUMMARY

Canine aggression toward unfamiliar people and dogs is a common behavior problem. Although a variety of factors are involved in the development of this problem, genetics and socialization deficits play a major role. This problem typically can be well controlled with targeted changes in the animal's environment, implementation of appropriate behavior modification exercises, and adjunctive pharmacologic support where indicated. Owners should be encouraged to seek professional help early in the problem before the dog actually injures another animal or human.

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