BEHAVIORAL ASSESSMENT OF AGGRESSION TOWARDS HUMANS IN THE DOMESTIC DOG

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To the Faculty of Washington State University:

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Above all, I thank my husband Nathan for his unequalled love, profound belief in my abilities and the belly laughs that got me through it all.
Behavioral assessment tools are used by companion animal professionals and animal rescue organizations to evaluate the risk of various behavioral problems in dogs. This dissertation encompasses three studies designed to assess the validity of such tools as predictors of canine aggression towards humans.

In the first study, an evaluation was made of a graded behavioral assessment tool used in a program for transporting dogs between shelters to enhance adoption rates. The tool was found to have test-retest reliability within, but not between, shelters. Dogs that failed the assessment were subsequently more likely to be euthanized due to human-directed aggression than dogs that passed the assessment. However, behavior in the assessment was not a reliable predictor of overall owner reports of aggression towards people following adoption.

The second study involved an investigation of a different behavioral assessment tool to identify behaviors exhibited during the assessment that were reliable in predicting human-directed aggression following adoption in dogs subsequently returned to the shelter. Findings indicated that aggression towards people was predicted by discrete behaviors displayed during
the assessment, with snapping, whirling and stiffening being associated with future bites at strangers, and growling and shying/cowering being associated with threatening both strangers and familiar people.

The third study investigated the effectiveness of the same behavioral assessment tool in discriminating between owned dogs with and without a history of aggression towards humans. The assessment was reliable for identifying dogs that had previously bitten humans, which exhibited more lunging and less looking away from the tester than dogs with no history of aggression.

This research indicates that behavior assessment has some predictive power in the detection of human-directed aggression in dogs. However, it was found that human factors involved in behavioral assessment at shelters, and in the reporting of aggressive behavior by dog owners, influenced the validity of data used to determine outcomes for dogs relinquished to shelters. An improved understanding of dog non-verbal communication and human-related factors is needed to improve predictability in assessment, thereby reducing the risk of canine aggression towards humans.
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Dedication

This dissertation is dedicated to my loving husband, Nathan and my truly marvelous daughter, Gabriella for the unfathomable love, enduring support and pure joy you bring to my life. For never doubting that I could finish and for helping me to realize all of life’s possibilities, I am profoundly grateful.
“The study of expression is difficult owing to the movements being often extremely slight and of a fleeting nature. A difference may be clearly perceived, and yet it may be impossible, at least I have found it so, to state in what the difference exists. When we witness any deep emotion, our sympathy is so strongly excited, that close observation is forgotten or rendered almost impossible; of which fact I have had many curious proofs. Our imagination is another and still more serious source of error; for if from the nature of the circumstances we expect to see any expression, we readily imagine its presence.”

(Charles Darwin, 1899)

Increasing rates of companion animal ownership worldwide are driving an increased focus on aggression directed by domestic dogs towards people. Aggression towards humans, including bites and threats, is one of the most commonly reported behavior problem in domestic dogs (Beck and Jones, 1985; Guy et al., 2001a, b; Hart and Hart, 1985; Lockwood, 1995; Lindsay, 2000; Wright and Nesselrote, 1987). Dog biting is a serious public health and safety concern, with estimates in the United States ranging from 0.5 million to 4.5 million dog bites occurring annually (CDC, 1997; 2003; Gilchrist, 2008; Sacks et al., 1989). Animal shelters have begun implementing formal behavior assessment protocols with the aim of detecting and predicting canine aggression towards humans. Although behavior assessment has been shown to be somewhat useful in predicting some behaviors in dogs, the canine expression of aggression
towards humans remains difficult to decipher (Bollen and Horowitz, 2008).

Darwin (1899) was the first to provide an authoritative account of the behavioral expression of rage and other emotions in animals including dogs. More recently, Scott and Fuller (1965) presented seminal work on canine social behavior, and Lorenz (1966) furthered the scientific exploration of dog behavior with a fine-scaled description of canine facial expressions. However, as Darwin (1899) remarks, the behavioral expression of emotion in animals is not only elusive, but is complicated by our own human reaction to its display. In our close association with dogs, we tend to neglect unbiased observation of dog behavior due to our inclination to impose human emotions and expectations upon dogs, which can cause us to overlook behavioral indicators of a predictable reaction. Human difficulty in appropriately reading and interpreting canine behavior leads to disagreement about which behaviors constitute evidence of aggressive intent. Inconsistency in behavioral testing procedures and tester biases add to failures in recognizing and predicting dog attacks.

The purpose of this review is to examine human-directed canine aggression and to consider how we can reduce its negative impact on society. After a brief introduction to the origins and social organization of the domestic dog, I shall examine the terminology, manifestation, and development of aggression in dogs, taking into account environmental influences, genetic influences, physiological mechanisms and the role of dominance. I shall draw upon literature on aggression in other species where knowledge about dogs is lacking. I shall then discuss the impact of canine aggression on human society and how behavioral assessment tools are being used to predict human-directed aggression. Behavior assessment instruments seem to hold great promise for reducing the risk of human-directed aggression but assessments alone have not yet been able to reliably predict such behavior. I shall, therefore, examine
problems with assessment and discuss ways to improve assessment tools in the future.

**Origins of the domestic dog**

The evolutionary origins of the domestic dog (*Canis lupus familiaris*) remain a topic of debate (Boyko et al., 2009; Cruz et al., 2008; Savolainen et al., 2002). There is geological evidence that the domestic dog evolved from wolves over 12 to 15 thousand years ago in close association with humans (Coppinger and Coppinger, 2001). Vila et al. (1997) proposes that dogs have multiple ancient origins dating back 135,000 years whereas other authors claim that dogs originated in Asia or other Old World sites between 15,000 and 40,000 years ago (Leonard et al., 2002; Savolainen et al., 2002). Phylogenetic studies of mtDNA sequences suggest that there have been multiple domestication events and back-crossings with wolves (Wayne and Ostrander, 2007) in diverse locations across East Asia (Ostrander and Wayne, 2005). Once domesticated, dogs dispersed worldwide and genetically diverse populations and breeds emerged (Björnerfeldt et al., 2006; Parker et al, 2007; Savolainen et al., 2002; Vila et al, 1997).

There are currently over 350 distinct breeds worldwide in relatively closed breeding pools, resulting in loss of genetic diversity within the breed and greater divergence between breeds (Spady and Ostrander, 2008; Wayne and Ostrander, 1999, 2005). Many modern European dog breeds emerged during the Victorian era (American Kennel Club, 1998), with selection for physical attributes as well as behavioral patterns including herding, guarding, agility, speed, hunting and companionship (Scott and Fuller, 1965). Breeds have been organized into an evolutionary hierarchy comprising five primary groups, one with nine ancient breeds from the Arctic, Asia, Africa and Middle East, and others corresponding to more modern
European breeds (Parker et al., 2007). Village dogs, a term applied to dogs living in association with people but allowed to interbreed with few restrictions, are not under the direct pressure of artificial selection and appear genetically distinct from modern European breeds (Parker, 2007). African village dogs are a mosaic of early indigenous dogs descended from early migrants to Africa and non-native mixed breeds (Boyko et al., 2009). The mtDNA haplotype diversity in African and Asian village dogs is similar, calling into question the hypothesized East Asian origin of the domestic dog (Boyko et al., 2009).

Despite controversy about origins of the domestic dog, there is agreement that dogs have adapted to live in close relationships with humans. Domestication, defined as the natural selection for tameness, leads to changes in appearance and behavior. In a classic selection study thought to mimic changes occurring in domestication, Belyaev found that, in the first generation, the offspring of wild red foxes selected for tameness were tamer than their parents although still fearful and difficult to handle whereas, by the 35th generation, the majority of foxes were docile and eager to establish human contact (Trut, 1999). The tame line of foxes showed less aggression and were less reactive to stressful stimuli. This investigation in foxes demonstrates how behavior can change within a species in a relatively short time. Likewise, domestication has led to behavior changes in the domestic dog. Dogs are more variable in their social behaviors, use different communication signals, and show greater play and affiliative behavior towards humans than their wolf predecessors (Coppinger and Coppinger, 2001; van Kerkhove, 2004). Breeds of dogs also display distinct behaviors and demonstrate behavior not found in gray wolves (Hare et al., 2002).

Evidence suggests that the domestication process has altered aggressiveness in dogs through selection for docility, stress tolerance and retention of juvenile characteristics (Clutton-
Brock, 1995). Artificial selection of dogs has also altered the expression of aggression within and among breeds (Björnerfeldt et al., 2006). Dogs once bred for ferocity in bringing down large game, such as the Great Dane, are now bred for docility as pet animals (Lockwood, 1995). Historically, developers of fighting breeds not only selected dogs for ferocity towards other dogs but for ease of handling by humans. Dogs showing aggression towards their handlers were excluded from breeding, thus resulting in a good sporting dog. It is unclear whether these selection criteria are uniformly applied in the current breeding of vicious guard dogs (Lockwood, 1995).

Social organization of dogs and wolves

Dominance refers to an individual’s priority of access to limited resources, and a dominance hierarchy is an emergent property of the dominance relationships between dyads. Dyadic relationships between dogs, and information inferred from captive wolf behavior, have been used to support the idea that dogs form dominance hierarchies through aggressive displays and attacks (Beach, 1982; Dunbar, 1978; Fox, 1965, 1975; Scott and Fuller, 1965; Scott and Marston, 1948). According to Scott and Fuller (1965), dominance relationships between dogs develop by 15 weeks of age, with litters varying in the rate of emergence of a dominance hierarchy (Scott and Fuller, 1965).

Evidence for dominance hierarchies in dogs is primarily derived from a series of experiments in which Scott and Fuller (1965) ranked dogs based on the outcome of staged dyadic contests over food. Dogs that blocked access to the food in these dyadic encounters were declared dominant (Beach, 1982; Dunbar, 1978; Scott and Fuller; 1965). Scott and Fuller (1965)
reported that the hierarchy was linear in this context, with an alpha dog dominant over all others, an alpha bitch dominant over all others except the alpha male, beta males and females dominant over all others except the alpha animals, and omega animals subordinate to all others (Fox, 1965). Dunbar (1978) found that that ranks assigned from dyadic contests over a bone tended to remain stable when animals were placed together in a group. However, these studies may not translate directly to social hierarchies in natural groups of dogs (Dunbar, 1978; Fox, 1965; Scott and Fuller, 1965; Scott and Marston, 1948). Different status outcomes could emerge when there are multiple dogs present. Also, although not studied in dogs, observers of agonistic encounters may be influenced by the outcomes of contests between other group members through transitive inference (Paz-y-Miño et al., 2004), inferring social status without engaging in dyadic agonistic contests with all other group members.

Another source of inference about dominance in domestic dogs has come from studies in wolves. In his seminal work on wolf behavior and ecology, Mech (1970) popularized the idea that there is a dominance hierarchy in wolf social groups organized under a top ranking male and a top ranking female, based on observations by Robert Schenkel of an artificial grouping of non-familial wolves in captivity. Zimen (1975) also described violent interactions between captive female wolves and concluded that the higher the rank of the wolf, the greater the display of aggression. However, in the 1990s after numerous summers observing wolf packs in natural habitats, Mech realized that previously held beliefs on wolf behavior were incorrect. He observed that, rather than pack members continuously vying for dominance, wolves formed familial social groups with the breeding “alpha” pair guiding activities of the pack and younger kin acting as helpers in raising the young (Mech, 1999, 2002, 2008). The young dispersed to form new breeding pairs with very few occurrences of overt aggression (Mech, 1999, 2002,
Thus, wolf social behavior is not ruled by acts of aggression or a rigid linear dominance hierarchy (Mech, 1999), and the matriarchal wolf or breeding pair typically maintain leadership rather than engaging in contests of strength over resources (Mech, 2008).

Feral dogs show no evidence of linear dominance hierarchies (Coppinger and Coppinger, 2001). Dogs living in feral packs tend to be scavengers rather than cooperative hunters, living in loose association with one another rather than in well-structured packs. They tend to be organized along familial lines with irregular recruitment of individuals (Bonanni et al., 2010). Village dogs maintain territories but rarely fight with other dogs (Coppinger and Coppinger, 2001). Free-ranging dogs establish affiliative relationships with closely related individuals and kin selection may promote cooperation, reducing the probability of individual aggressive contests (de Villiers et al., 2003; Bonanni et al., 2010).

Although domestic pet dogs, feral dogs, village dogs, and wolves all belong to the same species, mammalian social organization is not a static property of species. It can vary between populations depending on environmental conditions. Therefore, it is inappropriate to assume that there is a single form of social organization that applies to all populations of dogs and wolves. Contrary to popular belief, the application of “wolf pack theory” to explain the behavior of dogs is out-dated and not supported by research on either wolves or dogs. Further research is needed to understand the development and maintenance of social dominance relationships among owned domestic dogs, and the extent to which this concept can be applied to human-dog relationships.
Aggressive displays in the domestic dog

In general, aggressive behavior is defined as an attack (i.e., injurious act, Merriam-Webster Online Dictionary, 2010), or threat of attack, directed by one individual towards another or a group (Hand, 1986). The display of aggression is also termed agonistic behavior, which is defined as any behavior having to do with fighting including attack, threat behavior and defense (Immelmann and Beer, 1989). Aggression is affected by a variety of factors including genetics, learned responses, and environmental pressures, and is often defined contextually. Aggressive behavior is, thus, not a unitary phenomenon but constitutes a collection of behaviors that reflects multiple internal processes as well as external events and stimuli (Goodloe, 1996; Goodloe and Borchelt, 1998).

Canine threat displays comprise an array of body postures, facial expressions, and vocalizations including an upright forward orientation with muscles flexed and still, head up or horizontal, ears upright and immobile or flattened, eyes staring or fixed, piloerection, mouth open and taut, teeth exposed, prominent wrinkling of the forehead, growling and barking (Abrantes, 1997; Aloff, 2005; Simpson, 1997). Whereas biting is a key component in the predatory behavior of canids, it typically occurs at relatively low levels in social aggression directed towards conspecifics and humans (Lockwood, 1995). Agonistic behavior is a normal component of canine behavior that begins as early as two weeks of age with the first sign of the growl vocalization appearing during feeding interactions (Fox, 1968; Scott and Fuller, 1965).

Behavioral signs of aggression vary depending on the level of arousal and fear. Stressed dogs may show heightened responses such as more raised hair, growling and standing over their
opponent than non-stressed dogs (Beerda et al., 1999). Dogs may show some ambivalence in their body language and still be capable of attack. Dogs are often reported to be wagging their tails preceding an attack. In this scenario, tail wagging is a signal of arousal rather than greeting. A fearful dog may cower with weight shifted back and ears in a low position prior to attack (Aloff, 2005; Quaranta et al., 2007). Dog growl vocalizations also vary in acoustic structure depending upon the affective state evoked in different contexts (Faragó et al., 2010). Aggression is costly behavior that, when escalated, involves risk of injury or death. Dogs usually exhibit restraint in aggression within social encounters, relying on threats and avoidance rather than escalating to biting attacks in most cases. Dogs apparently learn to inhibit aggression through early experiences within the litter (Fox, 1970), and thwart aggressive attacks through signaling of defeat or deference (Abrantes, 1997).

**Terminology of aggression**

Aggression is often classified according to the apparent target of the attack and the inferred motivational state of the animal, although there are wide disparities in systems used to classify aggression that have hindered comparisons between studies (Serpell and Jagoe, 1996). The primary species used in experimental animal models of aggression are cats (Siegel, 2005) and rats (Panksepp, 1971). Experimenters tend to label forms of aggression dependent on the experimental methodology they employed (Siegel, 2005). These categories, defined by Moyer (1968, cited in Siegel, 2005), include the following;

Fear-induced aggression: attack behavior in the presence of a threatening animal, when escape is not permitted.
Maternal aggression: attack behavior when a mother is exposed to a threatening stimulus in the presence of her offspring.

Inter-male aggression: attack behavior elicited by a male towards another male. The aggressive bouts outweigh aggression that occurs between males and females or between two females, and aggression occurring within the aggressor’s territory may be excluded.

Irritable aggression: attack behavior in response to a threat, intimidation or environmental condition that is irritating. The response could be directed at a wide variety of subjects and is often associated with escape behavior. This form of aggression has also been termed defensive aggression or affective defense.

Predatory aggression: attack triggered by the presence of a prey stimulus. Predatory aggression is thought to be unrelated to other forms of aggression and appears to be mediated by different brain regions than those activated in other forms of aggression.

Territorial aggression: attack behavior directed toward an intruder when the intruder enters an area the attacker has deemed its domain. This behavior is evident in the resident-intruder experimental paradigm. The probability of attack in territorial aggression is dependent on the environment and the intruder. For instance, a female intruder may be less likely than a male intruder to elicit attack by a male resident or lactating female resident.

Clinical or diagnostic terms used to define aggression include territorial, irritable, fear/anxiety, possessive/resource guarding, protective, maternal, dominance, inter-male/sex-related, and predatory (Overall, 1997; Panksepp, 1998; Siegel, 2005), and are typically based on the presence of a specific environmental stimulus.
Many forms of aggression contain identical components including a real or perceived threat and/or fear, and the resulting aggressive behaviors such as erect posture, baring of teeth, vocalizations and biting attack. Underlying internal factors support the theory that aggression may not take numerous distinct forms as previously described but can be distilled into two discrete primary categories of aggression, affective attack (also referred to as affective defense, defensive rage, or the RAGE system) and predatory attack (also termed quiet biting attack) (Panksepp, 1998; Siegel et al., 1999; Siegel, 2005). These terms are used by neurobiologists to describe two distinct forms of aggressive behavior evoked by electrical stimulation of discrete brain regions. For example, when electrically stimulated to perform affective attack, cats exhibit piloerection, autonomic arousal, hissing, and growling when attacking whereas, when stimulated to perform predatory attack, they exhibit stalking and directed pouncing (Gregg and Siegel, 2001; Panksepp, 1998).

Specifically, electrical stimulation of predatory attack in cats is characterized by the animal suddenly becoming alert, then stealthily circling (stalking) and attacking with a well-directed bite to a prey animal’s neck (Siegel et al., 1999). If repeatedly stimulated, the cat continues to bite or shake the prey (Gregg and Siegel, 2001; Siegel, 1999). Unlike affective attack, sympathetic signs of arousal are absent from predatory attack, aside from papillary dilation (Han et al., 1996). The behavior in this form of attack is coordinated and visually directed (Gregg and Siegel, 2001). When electrically stimulated, cats prefer to attack a live or stuffed rat than an artificial model rat, confirming that this form of attack involves discriminating processes (Levinson and Flynn, 1965, cited in Siegel, 2005).
Affective attack can be defined as offensive or defensive depending on the accompanying body postures and environmental factors such as the position of the opponent, strategy of the opponent, and characteristics of the opponent such as strain or sex (Adams, 1979, 2006; Blanchard and Blanchard, 1989; Blanchard et al., 2003; Hetts and Estep, 2000).

Offensive attacks are directed at the head and dorsal surface of the offending target and include a sideways posture and bite-and-kick attack (Adams, 1979, 2006; Blanchard and Blanchard, 1977). Defense is described as occurring in the presence of a perceived dangerous conspecific, with the head and snout being the targets for attack (Blanchard et al., 2003). Defense involves freezing or flight locomotion and lunge-bite attack (Adams, 1979, 2006). In the cat, defensive behavior in response to the presence of a conspecific or other animal perceived as a threat includes flattening of the ears, lowering of the body, drawing in the head, piloerection, hissing, stiffening of the tail, and pupil dilation (Leyhausen, 1979). Attack is initiated with a striking of the paw and, if the opponent attacks in response, the defensive cat rolls onto its back exposing its underside to the opponent (Leyhausen, 1979).

In the resident-intruder experimental model, offensive attack is typically demonstrated by the resident when its territory is invaded by introduction of an intruder. In rats, the resident shows threat behavior including piloerection and a lateral attack with primarily superficial bites to the back of the opponent (Siegel, 2005). The location of the bite wounds can be dependent on the environment, with resident rats in smaller cages wounding their opponents on the upper part of the back and those housed in larger cages producing more wounds to the head and belly of their opponent (Gregg and Siegel, 2001; Kruk et al., 1979; Siegel, 2005). The intruder rat exhibits defensive affective attack when attacked by the resident and unable to escape. The defensive behavior features a lunge and bite attack to the face or other parts of the body of the
resident, squealing, flight, freezing, and 22 kHz ultrasonic vocalization (Adams, 1979, Blanchard and Blanchard, 1989; Siegel et al., 1999). When evoked by electrical brain stimulation, the defensive rat also attempts escape behaviors such as retreat and jumping from the cage (Panksepp and Trotwill, 1969).

There remains some disagreement whether affective attack and defensive rage are controlled by one or two primary neural pathways (Adams, 1979; Blanchard and Blanchard, 1977; Blanchard et al., 2003; Ferrari et al., 1996). Given that stimulation of brain regions that elicit affective attack also produces escape behaviors (Panksepp, 1971, 1998), Siegel (2005) proposes that the utility of ascribing offensive and defensive motivational terms to aggression elicited through electrical stimulation of the brain is questionable. He recommends use of the more general term ‘affective attack.’ Based on this view, affective attack can be considered to include fear-induced, maternal, inter-male, irritable, and territorial aggression given that all of these behaviors share a common feature, an emotional aggressive response including elements of fear and/or threat which may be real or perceived (Siegel, 2005). In natural conditions, the object of the affective attack is typically a competitor for resources.
Neural mechanisms of aggression

Studies in cats and rats have helped elucidate brains areas and neurotransmitters underlying aggression, providing a possible model for human-directed aggression in dogs. Aggression elicited by electrical stimulation of the hypothalamus and periaqueductal gray (PAG) suggests similar underlying mechanisms for aggression in both species (Gregg and Siegel, 2001; Kruk et al., 1983; Panksepp, 1971; Panksepp and Trotwill, 1969; Siegel et al., 1999). The core of the affective attack system runs from the medial amygdaloid areas downward, primarily via the stria terminalis, to the medial hypothalamus and from there to regions of the PAG (Gregg and Siegel, 2001; Siegel et al., 1999). Affective attack behavior is evoked by electrical stimulation of the medial hypothalamus or dorsal PAG (Siegel et al, 1999) and, specifically, sites within the rostral and dorsolateral PAG (Gregg and Siegel, 2001). Affective attack elicited by electrical or chemical stimulation of the medial hypothalamus is regulated by other limbic and cortical structures such as the cranial nerve nuclei and solitary nucleus, which receive input from the PAG (Gregg and Siegel, 2001; Siegel et al., 1999).

Predatory attack behavior is evoked by electrical stimulation of the lateral hypothalamus and, especially, the perifornical region, and a stereotyped form of this behavior may be elicited by stimulation of the ventral PAG (Gregg and Siegel, 2001). Animals self stimulate the lateral hypothalamus for predatory aggression, suggesting that it is a rewarding behavior as opposed to affective attack, which produces escape behavior when evoked by electrical stimulation of the medial hypothalamus (Panksepp, 1971; Siegel, 2005).

Electrical stimulation of specific brain regions usually evokes bites to the head or neck of an opponent whereas the lateral or sideways attacks typically present in inter-male fighting are
not induced by electrical stimulation (Kruk, 1991). This observation signals a need for caution in relating electrical stimulation studies of aggression to the natural aggressive behavior of animals.

Several classes of neurotransmitters have been identified as playing a role in the regulation of aggressive behavior, some potentiating aggressive behavior and others inhibiting aggressive responses. Excitatory neurotransmitters such as acetylcholine facilitate aggressive responses (Siegel et al., 1999). These findings are based on applications of cholinergic agonists and antagonists within the medial hypothalamus. Cholinergic agents potentiate affective attack in cats (Siegel, 2005). Both dopamine (mediated through the D2 receptor) and norepinephrine have similar potentiating effects on affective attack (Shaikh et al., 1991).

Serotonin (5-HT) both facilitates and suppresses aggression. Activation of 5-HT2 receptors in the hypothalamus and limbic system facilitates affective attack whereas activation of 5-HT1A receptors in the PAG or medial hypothalamus suppresses affective attack (Hassanain et al., 2003). There is evidence that the serotonergic system plays a role in canine aggression (Peremans et al., 2005). The drug fluoxetine, which inhibits the reuptake of serotonin, can reduce owner-directed aggression over the course of a three-week treatment (Dodman et al., 1996). In a functional imagining study, Peremans and colleagues (2005) found that aggressive dogs showed a higher binding index for serotonin receptor type 5-HT2A in cortical regions than non-aggressive dogs. The results suggest that impulsive aggressive behavior in the dog may be related to serotonergic activity but it is not yet clear how the altered binding of the 5-HT2A receptor subtype is involved. Canine aggression towards humans may be affected by a dysfunction in serotonin neurotransmission. Dogs aggressive to humans have been reported to have lower concentrations of the serotonin metabolite 5-Hydroxyindoleacetic acid in cerebral spinal fluid, as measured with high-performance liquid chromatography using electrochemical
detection, compared to non-aggressive dogs (Reisner et al., 1997).

Glutamate is another neurotransmitter in pathways associated with the expression of aggressive behavior. Glutamate neurons projecting from the medial hypothalamus to PAG mediate affective attack through N-methyl-D-aspartic acid (NMDA) receptors (Gregg and Siegel, 2003). Glutamate neurons that project from the basal amygdale to the PAG also facilitate affective attack behavior via NMDA receptors (Siegel, 2005).

Studies have also focused on the tachykinin neuropeptide substance P (SP), and its most potent tachykinin receptor, the neurokinin-1 receptor (NK1), in the mediation of aggression (Gregg and Siegel, 2001; Katsouni et al., 2009; Kruk et al., 1983). SP is an excitatory neurotransmitter, which acts by activating the hypothalamic NK1 receptors and is involved in the induction of affective attack in the cat (Gregg and Siegel, 2001; Shaikh et al., 1993). SP neurons of the stria terminalis that project from the medial amygdale to the medial hypothalamus potentiate affective attack and suppress predatory attack (Han et al., 1996). Micro-injections of an NK1 agonist into the PAG produced spontaneous aggression-related behaviors such as hissing in the cat (Gregg and Siegel, 2003) and, furthermore, NK1 receptor knockout mice had lower levels of aggression than controls in a resident-intruder model (Katsouni et al., 2009). SP is also involved in the prolonged response to pain and is released after prolonged stress in guinea pigs (Kramer et al., 1998). Several NK1 antagonists have been used to selectively inhibit SP activity involved in the behavioral stress response of rats (De Felipe et al., 1998; Katsouni et al., 2009). SP antagonists have been shown to decrease electrical stimulation-derived affective attack in cats, with their anxiolytic effect proposed to play a role in this effect (Siegel et al., 1995). SP has also been found to suppress predatory attack in cats elicited by stimulation of the lateral hypothalamus. The proposed mechanism for this effect is that stimulation of the medial
amygdale activates SP receptors in the medial hypothalamus, which triggers an inhibitory mechanism from the medial to the lateral hypothalamus resulting in a suppression of predatory attack (Han et al., 1996).

**Genetics of aggression**

Because of different closed breeding pools and selective breeding for specific behavioral traits, the domestic dog is considered an excellent model for the study of behavioral genetics (Liinamo et al., 2007; Ostrander et al., 2000; Sutter and Ostrander, 2004; Wayne and Ostrander, 2007). Aided by mapping of the canine genome (Kirkness et al, 2003; Lindblad-Toh et al., 2005), researchers have been focusing efforts on canine behavioral genetics both to understand dog behavior and as a model for human psychiatric disorders (Dodman et al., 2010; Overall, 2000). For example, through genome-wide association analysis of 92 rigorously phenotyped Doberman pinschers, Dodman and colleagues (2010) identified a gene region on one chromosome associated with compulsive flank sucking and blanket sucking. Dogs expressing both behaviors had a higher frequency of the risk allele than dogs exhibiting only one, or neither, of these behaviors (Dodman et al., 2010). The gene region identified is involved in the production of an adhesion protein, cadherin (CDH2), that may also be involved in human Obsessive Compulsive Disorder given that cadherins have been implicated in human autism spectrum disorder, which also includes repetitive or compulsive behaviors (Wang et al., 2009).

Despite Dodman et al.’s (2010) success, research on canine behavioral genetics is often hampered by inconsistent behavioral phenotyping. For example, researchers involved in the
Canine Behavioral Genetics Project currently underway at the University of California in San Francisco have been hindered by difficulty in defining behavioral phenotypes despite a focus on a single form of anxiety, noise phobia (Overall et al., 2008). Confounds include dog breed, training, environment, health, as well as how the owner, researcher or veterinarian classifies and reports the behavior. Canine behaviors that occur regardless of motivational context or training will most likely be readily mapped whereas elucidating the genetics mechanisms underlying complex and indeterminate behaviors such as aggression will prove more difficult (Parker and Ostrander, 2005; Spady and Ostrander, 2008).

Defining aggressive phenotypes is problematic given that there are many contexts for aggressive behavior in dogs and the extent to which differing contextual displays of aggression are controlled by different genetic mechanisms is unclear. In examining behavior of one breed, the Golden Retriever, van den Berg and colleagues (2003) found that behavioral tests were hard to standardize and that the variation between environments, testers and owners was too great to meet the level of standardization needed for a genetic analysis of aggressive phenotypes. More recently, however, Liinamo and colleagues (2007) reported progress in phenotyping human-directed aggression in Golden Retrievers. They derived heritability estimates based on behaviors reported by owners in Hsu and Serpell’s (2003) Canine Behavioral Assessment and Research Questionnaire (C-BARQ). The most reliable heritability estimates were derived from owner impressions of human- and dog-directed aggression. Both estimates were very high, 0.77 and 0.81, respectively, and had a low standard error (0.09). They found that certain questions in the C-BARQ were particularly revealing. For example, a question about aggression when a strange adult approaches the leashed dog revealed more about genetic differences in aggression between dogs than an item about aggression when verbally corrected by the owner. This study provides
support for using these behavioral measures in future studies on human-directed aggression.

Despite recent advances, canine behavioral genetics is still in its infancy. The greatest understanding we have of canine behavioral genetics comes from the classic work of Scott and Fuller (1965), who described breed differences in behavioral traits. Puppies from five distinct breeds (Terrier, Beagle, Basenji, Cocker Spaniel, and Sheltie) were reared in identical conditions and then tested at various ages on various behavioral tasks measuring traits such as trainability, emotional reactivity, and problem solving ability. In a test of emotional reactivity in which the puppies were subjected to minor restraint on a testing table, they found distinct breed differences in reactions to the stressor. Terrier, Beagles, and Basenjis were consistently more reactive than Shelties or Cocker Spaniels. The more emotionally reactive breeds had higher resting heart rate levels and were more prone to express behavioral reactions such as panting, lip licking, vocalizations, elimination, and tail wagging in response to restraint. This evidence lends support to their conclusion that heredity greatly affects the expression of emotional behavior and that differences in emotional behavior contribute prominently to the characteristic behavior of breeds (Scott and Fuller, 1965).

Some breeds, such as German Shepherds and Dobermans, are known for having a low threshold level for aggression, and this behavior is exacerbated by continued selection for aggression in some lines of these breeds. However, genes alone do not determine behavior. The environment determines how, when, or if certain behaviors are expressed. Much of dog behavior is flexible and can be drastically modified by learning and experience (Serpell, 1987). Although breed differences in traits such as tameness are related to alleles (Scott and Fuller, 1965), the degree to which these inherited tendencies become manifest in the adult dog depends crucially on experiences during the early phase of social development, termed the sensitive period for
socialization. Dogs with inherited low aggression thresholds may not display aggression if given
the appropriate early learning experiences.

**Early social experience**

Certain events and experiences, or lack thereof, during rearing can have long-term effects
on the behavior of dogs. Early studies of genetics and social behavior of the dog revealed four
distinct stages of development: the neonatal period; the transition period, the socialization period
and the juvenile period (Scott, 1962; Scott and Fuller, 1965). Scott and Fuller (1965) found that
puppies are more impressionable or agreeable to socialization during the socialization period
than later in life. This period was first described as a critical period, a time in early life when the
pup is developmentally influenced by certain stimuli present in the environment (Fox, 1968; Fox
and Stelzner, 1966, 1967). Although originally conceptualized by Lorenz as a strictly restricted
developmental time window, the boundaries of a critical period, now referred to as a sensitive
period, are not as abrupt or absolute as once thought (Fox, 1970; Serpell, 1995). A sensitive
period denotes a period in development in which behaviors or preferences are acquired more
readily than at other times in development. The puppy enters the sensitive period for
socialization at three weeks and, although the upper boundary to this period is difficult to
pinpoint, it is somewhere around eight weeks and corresponds to the weaning period in puppies
(Scott, 1962; Scott and Fuller, 1965). The dog is neurologically mature at four weeks, with the
exception of certain locomotor abilities, and it is at this time that the pup begins to interact with
littermates and develop primary social relationships (Fox, 1970; Scott and Fuller 1965; Serpell,
Selective deprivation studies have shown how early experience can alter the social relationships of dogs, affecting learning, sexual behavior and social communication (Fox, 1965). Pups reared without access to other dogs show marked deficits in their responsiveness towards members of their own species (Fox and Stelzner, 1967). In a study of Terrier pups reared in isolation or with conspecifics, when the two groups were introduced at 16 weeks of age, the pups were strikingly different in their responses to conspecifics. The isolates appeared stupefied and the other pups attacked them. When the isolated pups attempted to fight back, they were ineffectual, and this prevented the development of positive relationships (Scott and Fuller, 1965). Dogs reared under complete isolation from three days to 20 weeks of age showed abnormal EEG and overt behavioral abnormalities associated with excessive arousal, displaying sensitivity, hyperactivity, freezing, immobility, and withdrawal upon emergence from the isolated condition (Fox, 1970). These findings show that social experience is essential for the normal development of the dog.

**Effects of play experience**

Play is claimed to improve social relationships and decrease the incidence of aggression between dogs, although empirical evidence is lacking (Overall, 1997). Play begins at 21 to 23 days of age and generally takes the form of mouthing. Play fighting begins by four to five weeks of age as the puppies' motor and sensory skills develop (Bekoff, 1974; Scott and Fuller, 1965). Play is reported to be important in communication between dogs (Bekoff, 1977, 1995). The canine play bow, characterized by the dog crouching on its forelegs and elevating its hind end,
has been described as a "fixed" play invitation signal that shows stereotypy in both duration and form (Bekoff, 1977). From this position, the dog is able to perform a number of locomotor actions such as lunging and jumping (Bekoff, 1974). Bekoff (1977) found that there was no significant difference in form of the play bow between infant coyotes, wolves, wolf hybrids and domestics dogs, as measured on a grid system by the vertical displacement of the shoulders, suggesting that the play bow behavior pattern has a strong genetic component. The play bow is thought to have a metacommunicative function, communicating the intent to play in a stereotyped form that reduces signal ambiguity (Bekoff, 1972, 1977, 1995). From a functional perspective, clear play signals can help animals detect that the encounter will be playful rather than aggressive, thereby enabling them to avoid engaging in interactions that could be harmful.

Early play experience can alter rates of aggressive behavior later in life. For instance, in pigs, those receiving more opportunities for social play prior to weaning exhibited more rapid resolution of dominance relationships with unfamiliar pigs when they were later mixed (Newberry et al, 2000). In social play, animals reciprocate frequently between winning and losing postures, enabling them to gain experience of these situations while in a safe context (Špinka et al., 2001). They may also discover the limits in roughness of play because, when playful behaviors are delivered too roughly, the play partner terminates the play bout (Panksepp, 1998; Špinka et al., 2001).

Playful encounters likely allow dogs to develop social skills and refine their ability to recognize social signals that represent play or serious aggression. In this way, play may assist the dog in learning to better evaluate his adversary's fighting ability and respond with appropriate actions. Furthermore, in play, animals encounter situations that can lead to sudden loss of control (e.g. by losing balance). By learning to cope with these unexpected experiences, they
may be better prepared for future aggressive encounters with strangers and with other stressful events (Špinka et al., 2001). Therefore, dogs with more play experience may be better able to cope with and diffuse unexpected aggressive encounters.

Different breeds may differ in levels of play behavior performed when young, possibly accounting to some extent for breed differences in level of aggressive behavior. Furthermore, since early weaning results in separation from littermates and, therefore, a reduction in play opportunities with littermates, aggression may be more prominent in litters of dogs that are weaned earlier as opposed to later in development. In addition, since weaning is a stressful event that suppresses playful mood for a period following weaning (Donaldson et al., 2002), weaning and separation of dogs from littermates during the socialization period may further reduce playful social experience resulting in more aggressive responses during future social encounters. Following weaning, keeping young dogs alone, with limited opportunities for play, may also pose a risk factor for aggressiveness later in life.

**Maternal effects**

Evidence from other species indicates that mothering style can affect future behavior although there is limited information about specific effects on aggression. In mice, those of a strain with attentive mothers who spent a relatively high amount of time at the nest were less reactive and showed more exploratory behavior in a light box than those of a strain that had mothers showing a relative lack of maternal care (Calatayud and Belzung, 2001). In humans, children that experienced warm maternal responsiveness (praise, enthusiasm, encouragement, physical affection) developed superior social skills relative to children reared by mothers who
used power-assertive disciplinary tactics (Steelman et al., 2002). Early warm maternal 
responsiveness, whereby the mother responded supportively to her child’s behavior, was directly 
related to the child's social skills (e.g., compliance to requests) at the age of 54 months (Steelman 
et al., 2002). Isolation, or total lack of maternal care, was found to increase aggression in rats 
(Byrd and Briner, 1999) and primates (Kraemer et al, 1996). Investigations have also indicated 
an influence of mothering style on infant independence in Japanese macaques (Bardi and 
Huffman, 2002) and responses to the external environment in Vervet monkeys (Fairbanks and 
McGuire, 1988).

There is evidence that early social experience with the mother can alter gene expression, 
thereby altering behavior later in life. In rats, pups with mothers that made more contact during 
early ontogeny through licking and arching their back when nursing differed in their responses to 
novelty compared to pups with mothers who made lower levels of contact. As adults, high 
contact pups showed a decreased startle response, increased open-field exploration and shorter 
latencies to eat food in a novel environment compared to pups receiving low maternal contact 
(Caldji et al., 1998). This behavioral difference was attributed to alterations in the expression of 
the neurotransmitter, gamma-aminobutyric acid subunit receptors in brain regions associated 
with fear, including central, lateral, and basolateral nuclei of the amygdala as well as the locus 
ceruleus (Caldji et al., 2003). The same process may alter dog propensity to display aggressive 
behavior in adulthood.

Observational studies of mother-young interactions have provided preliminary 
information about the role of dog mothering style on puppy behavior. Wilsson and Sundgren 
(1998) found that puppies raised by more experienced mothers were more likely to engage in a 
tug of war game with an experimenter during a behavior test, suggesting that mothering style had
an influence on subsequent playfulness with humans. Wilsson (1984) found that German Shepherd bitches showed both qualitative and quantitative differences in behavior exhibited toward their pups. Some mothers were rough when delivering "inhibited bites" and continued this behavior after the puppies attempted to withdraw. Frequencies of this aggressive behavior reached a maximum during weeks 7 to 8, corresponding with weaning, when mothers used signals such as inhibited bites and growling to thwart nursing attempts. In contrast, other mothers took puppies in their mouths without showing any signs of aggressiveness and groomed the puppies vigorously afterwards. Wilsson (1984) suggested that dogs receiving more aggressive contacts from their mother during rearing would show more submission during training, thereby increasing their trainability. However, this prediction seems questionable considering that she also found that inhibited biting, nibbling, and licking by the mother were all negatively correlated with puppy contact with humans in a test at 8 weeks of age. Moreover, in a study of German Shepherd dogs in Sweden, Strandberg et al. (2005) found that maternal heritabilities for personality traits such as playfulness, boldness, fearlessness, and aggression were all low (0.01-0.08), and that littermates had a larger effect on these traits than the mother. Other environmental influences such as training and upbringing practices may have washed out any maternal effects on the pups since pups were weaned at 8 weeks and not tested until one to two years of age (Strandberg et al., 2005).

Whereas exposure to mild stressors when young may buffer later responses to stressors, severe stress when young may have the opposite effect, magnifying responses to subsequent stressful experiences (Anisman, 1998). This might explain why, in dogs, prolonged separation from the mother produces hyper-reactions to stressors later in life (Appleby et al., 2002; Fox and Stelzner, 1967). Disruption of the mother-young bond may result in disruptions in the
production of neurotrophic factors during critical developmental stages, reducing neuronal plasticity and leading to increased vulnerability to psychopathology such as severe aggression (Circuli and Alleva, 2003). Slabbert and Rassa (1993) observed that German Shepherd pups weaned from their mother at 6 weeks exhibited greater weight loss, lower levels of resting, and more crying behavior than those weaned at 12 weeks. Further work is needed to assess effects of weaning age on the development of aggression in dogs.

**Winner-loser effects**

The role of past fighting experience on canine aggression has not been formally assessed, although studies in other species indicate that prior winning tends to increase, and prior losing tends to decrease, the probability of aggression occurring in a subsequent contest (Chase et al., 1994; Hsu and Wolf, 1999). Defeated mice were found to be less aggressive (Ginsberg and Allee, 1942), and defeated chickens were found to be more submissive (Ratner, 1961), in successive encounters. Having won or lost a previous encounter also reliably predicts the outcome of the next encounter in goldfinches (Popp, 1988). In a study of rats, those that experienced defeat in aggressive encounters with unfamiliar rats of an aggressive strain showed consistent losing behavior when paired with rats of a more submissive strain and this effect persisted up to 14 days (van de Poll et al., 1982). Frischknecht et al. (1982) showed that mice that experienced successive losing bouts exhibited an increase in submissive behaviors (crouch, defensive movements, freeze, and vocalization). They found that a mouse defeated by an aggressive mouse on day 1 would generalize this learned submission to other non-aggressive mice encountered on day 3.

Experience of winning or losing has been shown to be a predictor of dominance in mice.
(Ginsburg and Allee, 1942), chickens (Cloutier and Newberry, 2000; Ratner, 1961) and boobies (Drummond and Canales, 1998). For instance, Drummond and Canales (1998) found that boobies with prior experience of winning contests with a familiar subordinate conspecific were able to establish the dominant position in a later contest with a foreign conspecific. Conversely, boobies that lost encounters with a dominant familiar conspecific remained subordinate in contests with unfamiliar conspecifics. These dominant/subordinate relationships remained stable after the last test day. In chickens, Cloutier and Newberry (2000) reported that social rank within a stable social group, based on the outcome of aggressive interactions over the previous two weeks, was predictive of future social rank in a new group comprised of strangers.

Prior studies have shown that losing has a greater impact on future behavior than winning. The winner effect lasted 3 hours in sticklebacks (Bakker et al., 1989) and 60 minutes in pumpkinseed sunfish (Chase et al., 1994). Conversely, the losing effect lasted longer than 6 hours in sticklebacks (Bakker et al., 1989) and at least 1.5 hours in pumpkinseed sunfish (Chase et al., 1994). Drummond and Canales (1998) reported that the losing effect in boobies was pronounced for 10 days after pairing with a dominant contestant. These winner-loser effects have not been investigated specifically in dogs.

In the maintenance of social relationships, dogs experience challenges through play and agonistic encounters whereas deprivation of social experience may lead to escalations of aggressive behavior. In a study of first contests of male spiders, Whitehouse (1997) found that naïve spiders were more likely to escalate to aggressive contests rather than to display, an effect that persisted for at least 12 hours. Prior winning and losing experiences were hypothesized to affect how individuals assessed fighting ability (Whitehouse, 1997). Pups may receive winning and losing experience within the litter in contests with littermates and in relation to the bitch’s
mothering style. If a passive mother does not engage the pups in encounters in which they experience defeat, her offspring might be more aggressive later in life, as might dogs that lack sufficient losing experience in social play. Lastly, dogs may also experience winning and losing within the human-dog relationship. An absence of social control by humans when young may contribute to greater expression of aggression towards humans later in life.

The dog-human relationship

The study of aggression in dogs is complicated by the close relationship that humans maintain with pet dogs. Dogs living as companion animals display affiliative attachment behavior to humans but, despite selection for amicable behavior, some dogs also direct aggressive behavior toward their owners (Borchelt and Voith, 1986; Cameron, 1997; Line and Voith, 1986; Reisner, 1997; Voith and Borchelt, 1982). Many clinical animal behaviorists treat behavioral problems in dogs, including human-directed aggression, based upon the assumption that dogs form social relationships with humans that are equivalent to those with conspecifics (Beaver, 1983; Line and Voith, 1986; Overall, 1997). It is unclear how dogs classify different groupings of organisms including humans although learning based on individual experience is undoubtedly involved. Differences in aggressiveness towards humans are likely influenced by social experience gained from interactions with humans.

Early socialization with humans, before three months of age, is considered critical to the development of a dog with a good temperament and appropriate behavior around people (Dunbar, 2001). Drawing from research in other mammals, early handling, considered a low-level stressor, can mitigate responses to stressors in adulthood, particularly with respect to the
hypothalamic-pituitary-adrenal (HPA) response (Anisman et al., 1998). Thus, Battaglia (2009) proposes that early stimulation of dog pups with mild stressors activates the HPA response and improves later ability to cope with stress. He describes handling exercises for pups less than two months old, suggesting that they provide benefits including improved cardiovascular performance, “stronger” adrenal glands and more tolerance to stress resulting in greater resistance to disease (Battaglia, 2009). There is also anecdotal evidence that dogs exposed to large numbers of people early in ontogeny are less likely to exhibit aggression towards people. These claims have not been investigated experimentally.

In a study of experimental deprivation in which pups were removed from their mother and placed in isolation, those that were allowed interaction with human handlers two times a week for ten minutes showed fewer effects of isolation, such as prolonged latency to approach a human, than pups given once-a-week, or no, access to humans (Fuller, 1967). Pups reared with conspecifics but kept in social isolation from human handlers during this period became fearful and intractable to humans (Scott and Fuller, 1965). Fuller (1967) found that puppies could be socialized to humans during the sensitive period for socialization with as little as 20 minutes of human exposure a week. Further empirical evidence is needed to assess the impact of early and sustained exposure to people, and the quality and form of interaction, on human-directed aggression.
Classification of human-directed aggression

A variety of terminology is used to describe forms of aggression directed towards humans. I shall review the main classifications and, in particular, dominance and territorial aggression, which are the most commonly applied terms for aggression associated with bites to humans. It should be kept in mind that these terms imply an understanding of the underlying motivation of the dog. Furthermore, aggression may not manifest as a distinct category and multiple forms of aggression may be expressed by a dog.

When applied to dogs, the term “dominance” often becomes a label for a broad spectrum of behaviors rather than an outcome of contests between two individuals (Drews, 1993; Kaufman, 1983). The term, dominance aggression, is utilized by clinical animal behavior professionals in reference to the tendency of dogs to react aggressively towards humans in response to apparent changes in their position within the social hierarchy (Beaver, 1983; Cameron, 1997; Lockwood, 1995; Overall, 1997; Serpell, 1995). Dominance aggression is described as abnormal, inappropriate, out-of-context aggression that is manifested by dogs toward people when the dog attempts to control access to resources (Overall, 1997). The term is applied in contexts in which the dog is thought to be competing with a person to establish or maintain a dominant position (Hart and Hart, 1985). According to Lockwood (1995), dominant aggressive attacks are more likely to be directed at the owner, or the owner's family members, than at a stranger, and Line and Voith (1986) state that these attacks occur in circumstances compatible with protecting access to critical resources or resisting dominant gestures by members of the family. Specifically, the term is applied to situations in which a dog directs aggression to a person when (1) guarding a resource, such as a bone or resting place, (2) assuming postures such as "standing over" or "staring" at a person and/or (3) resisting behaviors...
delivered by a person, such as petting, hugging, pushing, or pulling. Unbeknownst to the owner, the dog is thought to be responding to dominant-appearing postures such as staring the dog in the eyes, petting the dog on the head, resting an arm around the dog's shoulder, or other interactions with the owner (Borchelt and Voith, 1986; Overall, 1997). The dog exhibits self-confident rather than submissive postures (Reisner, 1997), and is thought to resist submissive postures and unsolicited body contact, and object to being given commands or punishments (Young, 1989), for example, by growling or attempting to bite a human who tries to displace it from a sleeping place.

Borchelt and Voith (1986) claim that dominance aggression toward people can be seen in puppies as early as 6 weeks, but is often not obvious until 6 to 12 months. However, dogs more commonly will not present with behavior labeled as dominance aggression until social maturity, between 12-36 months (Beaver, 1999; Overall, 1997; Reisner, 1997). The behavior is most commonly reported in intact males and neutered females (Hart and Hart, 1985). As there is no direct evidence that dog social systems and dog-human social systems are equivalent, there has been a recent trend to replace the term dominance aggression with terms not involving social status, such as impulsive aggression (Peremans et al., 2005) or simply dog-human aggression. This removes the implication that the dog’s behavior is related to its social status with humans.

Another form of human-directed aggression is termed territorial aggression. Many dogs tend to react when a stranger enters an area that they inhabit, referred to as their territory, and, although it may be normal behavior for dogs, it is inappropriate for a positive relationship with humans if this behavior escalates into aggression towards people (Serpell, 1995). Some dogs can be territorial around places where they sleep, or in a mobile space around them, and become aggressive when anyone or anything enters that space. Restrictive spaces such as cars, crates,
chains, or fences may intensify this behavior (Overall, 1997). The term “territorial aggression” has also been applied to aggression occurring when a dog singles out a particular familiar person or family group to protect, and reacts to quick movements or approaches of others around their protected person(s) (Overall, 1997).

Predatory aggression is also a problem for humans, especially children. Dogs may silently stalk infants or react to the high-pitched cries and erratic, uncoordinated movements of young children. The dogs may see these as prey signals and these may provoke predatory aggression (Overall, 1997).

When flight attempts are thwarted, dogs may resort to fear-related defensive aggression, termed fear aggression. This form of aggression is a problem in dogs that have had a bad experience, or lack experience, of a particular situation. Fearful dogs may respond with bites when subjected to punishment or medical treatment, or when unable to flee from other stressful situations (Overall, 1997).

All forms of aggression towards humans appear to be altered by social experience but the extent to which experience with conspecifics or humans can influence the expression of this behavior is still unclear. There are perhaps indicators within the early social relationships among dogs and between dogs and humans that serve as predictors of adult dog behavior, such as behavior related to status.
The role of dominance in human-directed aggression

There is often an assumption among dog training professionals that dogs are motivated to establish hierarchical relationships with conspecifics and humans, and that aggression problems are expressions of conflict that arise when dominance status has been challenged (Overall, 1997). The dominance model of aggression in dogs has given rise to treatment protocols that instruct the dog owner to create or enforce dominance over the dog using “low-level dominance statements” such as having the dog frequently lie down on command (Borchelt and Voith, 1986; Hart and Hart, 1997; Line and Voith, 1986; Overall, 1997; Reisner, 1997; Voith and Borchelt, 1982). These subtle displays of dominance by the human are assumed to be recognized by dogs as honest signals of status (Dennis et al., 2008), resulting in deference by the dog without aggressive challenge.

These types of behaviors have been referred to by other authors as owner-dog interactive ground rules (Askew, 1996), deference behaviors (Overall, 1997), commands to assert authority (Hart and Hart, 1997), discipline and structure commands (Reisner, 1997), "nothing in life is free" commands (Hetts, 1999), social dominance commands (Campbell, 1972; 1999), leader of the pack instructions (Ulibarri, 2000, personal communication), and integrated compliance learning (Lindsay, 2000). They include ignoring unsolicited attention, commanding frequent sit and down postures, having the dog complete a command before receiving attention and/or reward, having the dog wait for you to go in and out of doors, feeding after you have eaten, controlling access to the food bowl, petting the dog on the belly while the dog is lying down, placing your hand on and holding the muzzle, laying your arm across the dog's shoulders, having the dog move out of the way, and not allowing the dog in the bed (Askew, 1996; Campbell, 1972; 1999; Hart and Hart, 1997; Hetts, 1999; Lindsay, 2000; Overall, 1997; Reisner, 1997;
Ulibarri, personal communication; Voith and Borchelt, 1982). Anecdotally, application of these behaviors appears to be at least moderately successful in reducing human-directed aggression, but empirical evidence is lacking.

Some dog professionals view these behaviors as offering structure and leadership within the human-dog relationship rather than as signs of dominance. Assuming that dog recognition of human signals is based at least in part on learning, these behavioral interventions likely operate on the principles of operant and classical conditioning. The behaviors are contingent on consequences, and behavior changes as a result of these contingencies. So rather than changing social status, dog owners may be establishing order by reinforcing appropriate behavior and/or punishing inappropriate behavior (Bradshaw et al., 2009; van Kerkhove, 2004). Leadership defined within this paradigm is the ability to influence the performance of behaviors that an animal would not normally perform on its own (Yin, 2007). Leadership can be achieved when a dog owner consistently sets clear limits for a behavior and effectively communicates the rules of behavior by rewarding correct behaviors and punishing or removing access to a reward (Yin, 2007). These principles work directly to change or prevent undesirable behavior, and rewards and punishments are then associated with the person delivering them.

**Breed differences in human-directed aggression**

Dog breeds have been shown to be genetically distinct and display breed typical behaviors (Wayne and Ostrander, 2007). Although genetics alone have not accounted for all behavioral disparities, there are some breed distinctions in the display of aggressive behavior towards humans. In a study of owner- and breeder-reported behaviors, Duffy and colleagues
(2008) found that Dachshunds, Chihuahuas and Jack Russell Terriers showed more aggression towards owners and strangers than other breeds. Australian Cattle Dogs showed more aggression toward strangers compared to other breeds, and American Cocker Spaniels and Beagles were more likely to direct aggression towards owners.

Several epidemiological studies have attempted to identify breeds conspicuously associated with a higher risk of bites despite difficulty in drawing scientifically sound conclusions due to wide variation between communities in how human bite cases are reported and investigated (Lockwood, 1995). It has been proposed that there are substantial breed differences in the propensity to develop aggression towards humans as determined by the number of bite fatalities in humans. In a study of fatal dog attacks, Sacks et al., (1989) reported that Pit bulls were ranked highest in the percentage of fatal attacks (12.3%), followed by Chow-Chows (11.4%), German Shepherds, Dobermans, and Rottweilers ranking third, fourth, and fifth, respectively. Although severe, these encounters represent a very small fraction of the millions of dog-human interactions occurring daily. In a follow-up study based on twenty years of data, Sacks et al. (2000) found that Pit bulls and Rottweilers ranked highest in fatal attacks followed by German Shepherds, Husky-types, Malamutes, Doberman Pinschers, Chow-Chows, Great Danes, and St. Bernards.

In a study of 245 cases of aggressive behavior (barking, growling, and biting behavior) by pet dogs, Borchelt (1983) commented that breed differences in the occurrence of aggression were difficult to interpret due to low numbers of dogs of each breed investigated, and high interbreed variability. They reported that dominance aggression tended to be relatively frequent in English Springer Spaniels, Doberman Pinschers, Toy Poodles and Lhasa Apsos, and infrequent in hounds. Possessive aggression occurred more frequently in Cocker Spaniels than
in other breeds, and protective-related aggression was more likely in German Shepherds than in other breeds. Fear-related aggression occurred in German Shepherds as well as Cocker Spaniels and Miniature Poodles.

Compelling evidence for breed differences in aggression comes from genomic research. In a study of 23 dog breeds selected from diverse places of origin (Europe/ North American and East Asian), 1,535 dogs were tested for the allele frequency distribution of gene exon III of dopamine receptor D4 (Hideyuki et al., 2004). Dogs with higher allele frequencies of exon III 447b, 498, and 549 (Group B) had higher scores for aggression-related behavioral traits and reactivity in behavior tests when compared to dogs with higher allele frequencies of exon III 435 and 447a (Group A). Breeds represented in Group B included the Siberian husky, Welsh corgi, Shih Tzu, West Highland white terrier, Shiba Inu, Akita, and Hokkaido Dog whereas breeds represented in Group A included the Miniature Schnauzer, Shetland Sheepdog, Toy Poodle, Pug, Maltese, Labrador Retriever, Chihuahua, German Shepherd, Beagle, and Golden Retriever. More detailed inspections of breed differences are being conducted to elucidate the contribution of geographical region and distinct lines within breeds to gene allele frequency distribution (Hideyuki et al., 2004).

Dog breeds came about through selective breeding for particular functional traits such as ferocity for guarding, size and strength for hunting large game, and tractability for pet dogs (Serpell, 1995). In modern Western societies, the practical function of dogs has greatly diminished in importance and the dog's role within the human family has become increasingly significant. However, dogs may still harbor the breed differences in behavior for which they were originally selected (Hart and Hart, 1985; Hart and Miller, 1985). Thus, it is possible that the breeds originally developed for their ferocity still embody these traits to some extent despite
selective breeding for companionship and human contact during the sensitive period for socialization.

**Dog bite statistics**

Dog bites due to aggression represent a serious public health concern in the United States and worldwide. The current U.S. pet dog population has been estimated at approximately 77.7 million (Pet Food Institute, 2010), associated with an annual dog bite incidence of 500,000 to 4.7 million people (CDC, 1997, 2003; Gilchrist, 2008; Sacks et al., 1989, 1996). The high estimate of 4.7 million people bitten, or 1.8% of the U.S. population, was derived from a 1994 national survey of 5238 randomly dialed American households (Sacks et al., 1996). It has been estimated that approximately 800,000 people in the U.S. seek medical attention due to dog bites annually, or 0.3% of the U.S. population (Quinlan and Sacks, 1999; Sacks et al. 1996). In a more recent survey using the same model as in the 1994 study, Gilchrist (2008) estimated that the overall incidence of dog bites remained relatively unchanged at 4.5 million, with 885,000 people seeking medical attention. Interestingly, the reported incidence of dog bites among children saw a 47% decline.

The best representation of harmful human-directed aggression comes from bite reports from people seeking medical attention and from reported fatalities due to dog bites. However, the majority of dog bites go unreported and, therefore, estimations may be unreliable. In a 1976 study of bite reports in New York City, less than 44% of bites treated in emergency room departments were reported to the health department (Beck and Jones, 1985). According to the Centers for Disease Control and Prevention (CDC), an estimated 368,245 people, or 129.3 per
100,000 members of the population, were treated in emergency departments for dog-related injuries in 2001 (CDC, 2003). Weiss and colleagues (1998) reported that dog bite injuries represent 1.1% of all emergency room visits.

Local bite reports from U.S. cities, counties and states vary. For example, in a one-year period, 87 bites per 100,000 people were reported in Oakland, California (population 399,000), and Alameda County (population 1.4 million), which includes Oakland, reported a bite rate of 80 dog bites per 100,000 people. In contrast, the nearby city of San Francisco reported only 49 per 100,000 people per year (Chin et al., 2007). Overall, hospitalizations from dog bites in the State of California averaged 835 per year from 1991-1998, with an incidence of 2.6 per 100,000 people (Fieldman et al., 2004).

Worldwide, dog bite statistics vary but bites remain prominent as a public health concern. In Lyon, France, 37.5 persons per 100,000 people per year reported dog bites (Chomel and Trotignon, 1992). In a New Zealand study from 1979-1988, dog bites totaled 4.8 per 100,000 people per year (Langley, 1992). Thompson (1997) found that 6500 people per year (73 per 100,000 people) were reported to have been injured in dog attacks in Adelaide, Australia. In Guelph, Canada, the bite rate for the one-year period of 1986-1987 was estimated at 160 per 100,000 people (Szpakowski et al., 1989). In Belgium, the incidence of dog bites was 900 per 100,000 people or about 1% of the population (Van Eeckhout and Wylock, 2005). In Bangalore City, India, 1.9% of the population was reportedly bitten annually (Sudarshan et al., 2001) and in Bangkok, Thailand, 5.3% of injuries seen in emergency rooms were dog-bite related (Bhanganada et al., 1993). In a comprehensive study of dog bites in Spain from 1995-2004, the annual incidence of dog bites was 12.8 per 100,000 people in high population areas and as high as 71.3 per 100,000 people in low population areas (Rosado et al., 2008). Despite inconsistent
reporting, these findings demonstrate that canine aggression towards humans has a great impact on society.

**Dog bite demographics**

Of all dog bites reported, most are from owned dogs (Beck and Jones, 1985; Bernardo et al., 2002; Kahn et al., 2003; 2004; Wright, 1985). Dogs are most often reported to bite familiar family members within the owners’ home or neighborhood (Avner and Baker, 1991; Bernardo et al., 2000; Guy et al., 2001a; Mitchell et al., 2003; Presutti, 2001; Sosin et al., 1992). Children under ten years of age are most often the target of dog attacks, with children under five to six years suffering the most severe injuries (Bernardo et al., 2002; Gandhi et al, 1999; Gershman et al, 1994; Greenhalgh et al. 1991; Mitchell et al., 2003). Injuries are most common on the face, head and neck (Karlson, 1984; Tuggle et al., 1993). Infants and incapacitated children wearing diapers can be susceptible to genital dog bite injuries. In a study of such injuries, Redman (1995) found ten reported cases. In addition, there are rare occurrences of predatory attacks on humans by packs of dogs (Borchelt et al., 1983).

Evidence that dog bites frequently go unreported comes from a study of unreported dog bites in children. Beck and Jones (1985) found that 45 percent of children had been bitten in their lifetimes, more than 36 times the rate reported to health authorities.
Dog bite fatalities

Statistics on dog-related fatalities are difficult to locate, indicating that fatalities from dog bites and attacks are rare. However, attempts have been made to track the numbers of people killed by dogs. Using data collected from the National Center for Health Statistics and computerized searches of news stories, Sacks et al. (1989) identified 157 deaths due to dog bites in the U.S. from 1979 to 1988, and 109 deaths from 1989 to 1994. Although rare, predatory attacks on people often result in fatalities (Borchelt et al., 1983).

Behavioral testing of domestic dogs

Because dog aggression towards humans presents a public health, financial, and emotional burden on society, there is interest in the use of behavioral testing of dogs as a tool to help prevent attacks on people. Behavioral testing for dogs has been ongoing since the classic work of Scott and Fuller (1965) on the genetics and behavior of the dog. Despite the growing number of studies into the behavior and temperament of dogs, there has been little consensus on how to evaluate behavior traits. In a review of the literature on behavioral testing in dogs, Diederich and Giffroy (2006) described the broad range of testing and emphasized the need for standardization.

Previous efforts to assess dog behavior have focused on the predictive value of puppy temperament tests between 6 and 12 weeks (Beaudet et al., 1994; Goddard and Beilharz, 1984, 1986; Scott and Beifelt, 1976; Wilsson and Sundgren, 1998). Testing usually involves exposing the pup to a number of controlled situations and human interactions (Serpell and Hsu, 2001). Early behavior tests alone have proven unreliable for predicting future behavior. Beaudet and
colleagues (1994) tested 39 seven-week old puppies with the "Puppy Aptitude Test" developed by Campbell (1972). This test included a number of human manipulations to the dog that were considered likely to be predictive of social tendencies with humans. However, when the puppies were retested at 16 weeks of age, researchers found no significant correlations between the social tendencies observed at 7 and 16 weeks (Beaudet et al., 1994). Using a behavior test intended to assess suitability of puppies for training as guide dogs, Wilsson and Sundgren (1998) tested 630 eight-week-old German Shepherd puppies. They found that performance in the puppy test showed no correspondence with adult guide dog temperament or ability. Serpell and Hsu (2001) evaluated a model that included an early behavioral assessment together with a questionnaire given to puppy raisers for evaluation of temperament. This model proved accurate and useful in predicting suitability as guide dogs. Reasons why early behavioral assessment alone is not predictive of adult behavior are not clear, especially given that most dogs are neutered and do not undergo large hormonal changes at puberty.

One of the first obstacles to standardization of behavioral testing is the inability to find consensus in terminology. The term temperament implies that specific behavior traits are present at an early age, consistently elicited by certain stimuli or situations, and relatively stable over time as a consequence of underlying genetic make-up. Environmental influences and learning experiences can intervene to shape personality over an animal’s life (Stur, 1987) although, in the dog literature, the term, temperament, is often used interchangeably with personality (Svartberg, 2002; Svartberg and Forkman, 2002). Multiple temperament traits have been represented by temperament categories (Murphy, 1998) or behavioral profiles (Goodloe and Borchelt, 1998). These studies look at clusters of behaviors or factors statistically related to each other that are thought to have functional unity such as “aggressiveness” (Diederich and Giffroy, 2006).
However, it is difficult to evaluate these functional units of behavior across studies given that the origins of dogs tested vary greatly, ranging from pet dogs (Sheppard and Mills, 2002) to shelter dogs (Ledger and Baxter, 1997) and dog colonies (Cattell et al., 1973). The term “temperament” has also been applied as a behavior trait itself. For instance, Slabbert and Odendaal (1999) reported that “temperament” was scaled from 0-1 in a test of a dog’s reaction to an eliciting stimulus. Diederich and Giffroy (2006) suggest that the word temperament should only be employed to characterize the dog’s behavior as a whole, with behavioral traits that make up the temperament being measured in an objective manner. Some authors avoid temperament, or temperament test, terminology in favor of terms such as behavior (Stephen and Ledger, 2007), behavior test (Wilsson and Sundgren, 1998), and behavioral evaluation (Bollen and Horowitz, 2008) because “temperament” is viewed as a subjective measure whereas behaviors can be observed and described objectively.

**Behavior assessments for predicting aggression**

Behavior tests have had questionable merit for identifying aggressive dogs (Campbell, 1972; Goddard and Beilharz, 1984; 1986), either because of too many false positives or, more commonly, false negatives (Diederich and Giffroy, 2006; Jones and Gosling, 2005). In a study of shelter dogs, van der Borg and colleagues (1991) tested dogs for four common behavior problems: aggression, fear, obedience, and separation anxiety. Their test resulted in a 74% probability of predicting problem behaviors in the home. However, for aggression towards adult humans, the test had only a 47.4% predictive value. Territorial aggression, which was also directed toward people, had 33.3% predictability. The test produced more false positives than did staff evaluations (van der Borg et al., 1991). In a study at the American Society for the
Prevention of Cruelty to Animals (ASPCA), Marder and colleagues (2003) found that a behavioral evaluation of shelter dogs produced a 46% predictability of aggression in the home after adoption, based on lunging or biting in the test. However, a negative result in the test was not predictive of future behavior. Christensen et al. (2006) reported that 40.9% of shelter dogs that passed a temperament test at the shelter showed some form of aggressive behavior within 13 months post adoption. Using a more nuanced assessment protocol, Bollen and Horowitz (2007) observed that dogs classified as “borderline,” exhibiting mild aggressive behaviors such as stiffening or slight growling when tested, were more likely to be returned to the shelter post-adoption due to aggression than dogs exhibiting no aggression in the test.

A majority of behavioral assessment in dogs has been done in relation to working abilities (Jones and Gosling, 2005). These studies have had more favorable results than those intended to identify aggressive dogs. Serpell and Hsu (2001) found that a behavioral questionnaire completed by the dog’s primary handler, coupled with a formal behavior test, reliably predicted the suitability of a dog for guiding work. Similarly, Weiss and Greenberg (1997) noted that, whereas temperament testing alone was not predictive of a dog’s ability for service work, when taken in conjunction with a trainer survey, it was predictive of fear and submission that would disqualify a dog from an assistance dog program.

Although some behaviors have been shown to have predictive value, aggression has still been difficult to forecast. Tests currently being employed in US shelters such as the Assess-a-Pet (Sternberg, 2002) and the SAFER program (Weiss et al., 2002) are currently being analyzed for predictability. The San Francisco Society for the Prevention of Cruelty to Animals (SF SPCA) has been utilizing a temperament test since 1999 in an attempt to identify which dogs entering their shelter may be aggressive towards humans, with the potential to bite. This temperament
test has been used to decide which dogs meet the adoption criteria outlined by the SF SPCA, and shelter personnel consider it a useful tool (Donaldson, unpublished observation).

The overall working hypothesis guiding this thesis is that standardized behavioral assessment of dogs at shelters is useful for identifying dogs likely to exhibit aggression towards people following adoption. The studies presented were designed to investigate the design and implementation of existing formal behavioral tests used at shelters for this purpose. The goal of the first study (Chapter 2) was to investigate the reliability of a graded behavioral assessment tool, currently in use at various urban animal shelters in the USA, in predicting adoption outcomes and identifying dogs with a propensity to bite. In the second study (Chapter 3), which was conducted at the SF SPCA shelter, discrete behaviors exhibited by dogs in the SF SPCA behavior test prior to adoption were evaluated for their association with post-adoption return of dogs to the shelter as a consequence of human-directed aggression and other owner-reported reasons for relinquishment. The goal of the third study (Chapter 4) was to assess the validity of the SF SPCA behavior test using owned dogs varying in owner-reported aggressive behavior history. The thesis concludes with a general discussion (Chapter 5) of the utility of behavior assessment for aggression as a tool for shelter personnel tasked with matching prospective adopters with suitable dogs. Shortcomings of these tests, and suggestions for improvement, are presented.
CHAPTER TWO

EVALUATION OF A BEHAVIOR ASSESSMENT TOOL USED BY ANIMAL SHELTERS FOR PREDICTING DOG ADOPTION OUTCOMES

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Abstract

This study examined the conclusion validity and test-retest reliability of a graded behavior assessment tool used by shelters participating in a dog adoption transport program. In this program, dogs were transported from an overpopulated region of the United States to an area offering a greater opportunity for adoption. Given the financial investment in each animal and the stress of travel, it was intended that only dogs highly suited for adoption would be considered for transport. Our goal was to examine the relationship between results of the behavior assessment performed at both an originating and a receiving shelter, and adoption outcomes. We predicted that dogs receiving a grade of B or higher in the assessment would be more likely to be adopted than dogs scoring C or lower. We also predicted that adopters of dogs scoring C or lower would be more likely to report that their dog exhibited signs of fear/anxiety and aggression toward humans compared to those adopting dogs with A or B grades. As predicted, we found that the probability of adoption was greater for dogs that had scored B or higher in the assessment than for dogs with lower scores (P < 0.001), which were more likely to be euthanized. Analysis of behavior problems reported by owners in the three months post-adoption revealed that the only behavior issue that was significantly more prevalent in dogs receiving a C or lower in the assessment was house soiling (P < 0.001). Counter to our predictions, the assessment outcome was not significantly associated with overall owner-reported human-directed aggression following adoption, and fear and anxiety issues were more common in dogs scoring B or higher in the assessment than in dogs with lower scores (P < 0.01). Test-retest reliability analysis revealed that there were no differences between test and retest scores when assessments were performed at the receiving shelter (P > 0.05) but there were differences (P < 0.001) in scoring of the kennel, food, and object sub-test components of the assessment tool.
when dogs were tested at the originating shelter and re-tested at the receiving shelter. The behavior assessment tool demonstrated conclusion validity in predicting adoption and euthanasia outcomes but was not reliable in predicting human-directed aggression following adoption. Our results suggest that human motivational factors, clarity of behavioral definitions, and inaccuracies in owner reporting of behavior need to be considered when applying behavioral assessment tools at animal shelters.

**Keywords**: Dog, Behavioral assessment, Aggressive behavior, Human-animal interaction

### 1. Introduction

The current pet dog population in the United States is estimated at over 77 million, with over 14 million dogs being adopted annually from animal shelters (American Pet Products Association, 2010). A major cause of dog relinquishment to shelters is objectionable behavior (DiGiacomo et al., 1998; Miller et al., 1996; Salman et al., 1998). When relinquished dogs with behavior problems are subsequently adopted from shelters, they may display objectionable behavior at the new home, resulting in dissatisfaction of the new owners and return of dogs to shelters. Of particular concern is biting by aggressive dogs, which may present a safety hazard not just to the new owners but also to members of the public. Shelters typically have limited resources to maintain dogs for adoption, and it is estimated that over half of the animals entering shelters are subjected to euthanasia (Zawistowski et al., 1998). Shelter personnel are faced with the difficult task of deciding which dogs are safe to place up for adoption, and which matches of dogs with potential adopters are likely to be successful as evidenced by a long-term attachment of the owners to their dog.
Standardized behavioral assessment of dogs entering shelters may be useful for identifying objectionable behaviors, and matching dogs with owners able and willing to address any particular behavioral issues identified. Such assessment procedures are increasingly being implemented at shelters but few of these tools have been formally evaluated. Those that have been investigated have exhibited some power for predicting certain behaviors in the home (Bollen and Horowitz, 2007; Ledger and Baxter, 1997; Marder et al., 2003; van der Borg et al., 1991). However, the reliability of these tools under varying shelter locations and conditions has not been widely evaluated.

We investigated a behavioral assessment tool currently in use at certain shelters in the United States. This tool is easy to administer and is being used in an attempt to improve the adoption success rate in a multi-shelter dog adoption program. In this program, dogs from over-populated shelters are transported to shelters where adoptable animals are in demand, decreasing the number of dogs euthanized each year. We obtained records from one of the transferring shelters (shelter 1) and one of the program’s largest receiving shelters (shelter 2) to determine if the assessment tool was predictive of adoption. The receiving shelter (shelter 2) accepts between 2,000 and 3,000 dogs annually through the transfer program. Shelter 2 has been conducting behavior assessments on all dogs entering the shelter from any source since 2000. Anecdotal reports from personnel at the shelter indicate that there has been a reduction in the number of dogs euthanized, and an increase in the number of dog adoptions, in the years since they began implementing the behavior assessment compared to past years when no assessments were performed.

Our goal was to examine the behavioral assessment tool for validity in predicting likelihood of adoption. We predicted that A or B scores in the assessment would be associated
with a greater probability of adoption than scores of C or lower, and that dogs receiving an A or B score in the assessment would subsequently be less likely to exhibit aggressive behavior, and signs of fear and anxiety, compared to dogs scoring a C or lower. Given its apparent efficacy in the transport program, we expected that the assessment would produce reliable results when utilized at both the transferring and receiving shelter, and that results of the assessment would remain stable over time when dogs were retested within the same shelter. We sought to determine whether our evidence would support the continued use of the assessment tool as a reliable predictor of adoptability in a variety of sheltering systems and by animal welfare agencies moving in the direction of a more standardized system of dog behavior assessment.

2. Materials and methods

2.1 Subjects

Subjects were 114 dogs older than six months for which records were obtained from two shelters over the course of six months. Records of 83 dogs came from shelter 1, a county shelter that has an annual intake of around 2,500 dogs, of which approximately 700 are adopted, 240 are euthanized and the remaining dogs are transported to other shelters or to breed rescue organizations. Dogs originating at shelter 1 were selected for assessment based on the impression of staff members of their likely success in the transport program. They were transported to shelter 2 in a customized air-conditioned vehicle equipped with kennels for individual housing while in transport. Records were also obtained on 31 dogs directly entering shelter 2, a private non-profit shelter that accepts relinquished dogs from private owners and from county animal control as well as through the adoption transport program. Shelter 2 has an
annual intake of over 4,700 dogs, of which approximately 3,200 are adopted, 480 are euthanized, and the others are transferred to breed rescue organizations.

2.2 Experimental groups

The study involved categorization of dogs into the following groups: (1) dogs (n=83) that were tested with the assessment tool at shelter 1, transported and re-tested with the same assessment tool at shelter 2, and (2) dogs (n=31) that were tested and retested with the assessment tool at shelter 2. Following the second assessment, these dogs (n=114) were (a) adopted, (n=104), (b) transferred to breed rescue organizations (n=5), or (c) euthanized without being placed up for adoption (n=5).

2.3 Behavioral evaluation

Assessments at shelter 1 were performed by shelter personnel trained in behavior evaluation, who had limited contact with the dogs prior to conducting the assessment. Dogs were housed at shelter 1 for 2 to 34 days before assessment. After assessment, they were kept in their kennels for 1 to 3 weeks before being transported to shelter 2, where they were kenneled individually and left undisturbed for 1 day before being retested by shelter 2 personnel. Assessments at shelter 2 were performed by trained Behavior Department staff members who were unfamiliar to the dogs prior to evaluation. Dogs entering shelter 2 directly were left undisturbed in individual kennels for 1 day before their first assessment, and retested 7 days later.
At both shelters, each dog was assessed individually by a tester who handled the dog and an observer who recorded the results. The tester and observer varied between tests and dogs depending on who was available. The assessment instrument comprised six sub-tests performed consecutively by the tester as follows:

**Kennel observation:** This sub-test was performed at the dog’s kennel (2.4 m x 0.9 m) within a kennel room (7 m x 5 m at shelter 1; 11 m x 5 m at shelter 2). The tester approached the kennel within 0.6 m in a neutral, non-threatening manner and stood quietly observing the dog for 15 to 30 s. The tester then spoke to the dog in a quiet tone, entered the kennel, and tossed a treat.

**Affiliation observation:** The tester removed the dog from the kennel with a slip collar and 1.8-m leash. The dog was taken to an outdoor fenced enclosure measuring 15 m x 9 m (shelter 1) or 23.5 x 17.6 m (shelter 2). The dog was then placed on a 6-m leash, which was dropped, and the dog was allowed to explore the yard for 60 s. The tester then called the dog in a high pitched, playful voice. The tester stood still and petted the dog if it approached. The tester then tossed a ball and attempted to engage the dog in play with the ball or other toy.

**Reaction to tester:** The tester walked the dog on leash into a test room measuring 4.8 m x 7 m (shelter 1) or 2.4 m x 2.4 m (shelter 2) and sat in a chair.

**Food bowl-resource guarding:** While in the test room, the tester placed a mix of dry and canned food in a food bowl. After the dog started eating, the tester approached the food bowl two times and attempted to remove the bowl with a model hand (Assess-A-Hand®, Great Dog Productions LLC, Accord, NY).
Toy test-resource guarding: The tester placed a variety of dog toys on the floor of the test room.

Body handling: While in the test room, the dog was handled by: (1) tugging slightly on the collar two times, (2) stroking the dog from head to tail four times, (3) touching and looking into both ears, (4) lifting the dog’s lip and looking at its teeth five times, and (5) lifting each foot and wiping it with a towel.

During testing, the observer followed the tester to the different test locations but remained quietly in the background and did not interact with the dog. The observer used the computer program, Petpoint (Pethealth, 2009), to record the dog’s response to each sub-test using a letter scoring system as defined in Appendix A.

At the end of the test, an overall test outcome, pass or fail, was determined. A dog that received an A or B grade in all sub-tests was considered by shelter personnel to have passed the assessment, meaning that the dog exhibited no serious behavior problems during the test. Dogs that scored C or lower in one or more of the sub-tests were considered to have failed the assessment, meaning that a potential behavior concern was identified. Failing dogs in our sample were precluded from being placed up for adoption at that time with the exception of those scoring C or lower in one of the resource guarding sub-tests (food or toy). These dogs were made available for adoption with caution to owners and information about resource guarding. If there was a conflict between the test and re-test scores, the lowest score was used to classify the dog as adoptable or not adoptable. A subset of dogs classified adoptable (based on passing the assessment or failing due to resource guarding) was transferred to breed rescue organizations rather than being placed up for adoption at shelter 2.
2.4 Follow-up information

Shelter 2 staff attempted to gain follow-up data from owners of each adopted dog at 3 days, 3 weeks and 3 months post adoption via a computer-generated e-mail questionnaire. When no responses were received after these three attempts, additional contact attempts were made by e-mail or, in some cases, a phone call, resulting in 100% compliance in follow-up information gathering. The follow-up questionnaire used by the shelter contained seven questions about the health and care of the dog and five questions pertaining to behavior issues encountered by the owner (house soiling, fear/anxiety, aggression to people, aggression to other pets, and resource guarding) since adopting the dog. Due to inconsistencies in owner reporting at the three follow-up time points, results from all follow-up responses received for each adopted dog over the three-month post-adoption period were combined for analysis. We used a 1-0 scoring system to classify dogs according to whether or not they were reported at least once to display each of the five behavior issues in the questionnaire. These behavior issues were not mutually exclusive.

When possible, follow-up information regarding these behavior issues was also obtained for dogs transferred to the breed rescue organizations, and from owners who returned dogs to the shelter within 3 months after adoption.

Decisions about euthanasia of dogs due to aggressiveness towards people were made by a shelter committee with input from multiple staff members. Behavioral modification techniques were applied to unadopted dogs that failed the assessment for reasons other than resource guarding, and these dogs were subsequently subjected to euthanasia if shelter personnel observed no improvement. In addition, dogs that were adopted or transferred and subsequently returned to
the shelter (including dogs with both passing and failing scores in the assessment) were subjected to euthanasia following return if the owner reported that the dog had bitten, or attempted to bite, people and if behavioral modification attempts following return were not effective.

2.5. Statistical analysis

All statistical analyses were conducted using NCSS (2000) software. Given that the data were categorical and not normally distributed, the Kruskal-Wallis one-way analysis of variance on ranks, corrected for ties, was used to examine relationships between variables. We investigated relationships between overall result of the assessment, C or lower (Fail) versus A or B (Pass) and subsequent outcomes for the dogs (adoption, transfer, and euthanasia). We employed the same statistical procedure to determine relationships between test result (Pass or Fail) and subsequent owner reports on the five behavioral issues identified in the follow-up questionnaire.

For test-retest comparisons of the assessment scores, the graded series of possible letter grades for each sub-test was converted to a graded series of numerical scores (e.g., for the kennel sub-test, A=1, B1=2, B2=3, C1=4, C2=5, D=6, F=7). A numerical representation of the sub-test scores allowed for statistical comparison of the differences in sub-test scores of the 83 dogs tested at shelter 1 and retested at shelter 2, and between the scores of the 31 dogs tested and retested at shelter 2. For each sub-test, the test-retest differences were analyzed using a two-tailed Wilcoxon matched-pairs signed ranks test on dependent data. Spearman rank correlation was used as a measure of degree of association between scores in the repeated assessments.
3. Results

3.1 Test conclusion validity

There was a significant relationship between performance in the assessment (pass vs fail) and outcome for the dog. Dogs that passed the assessment were more likely to be adopted ($\chi^2_{K-W} (1, 112) = 15.30, P < 0.001$), and less likely to be euthanized due to aggressive behavior towards people ($\chi^2_{K-W} (1, 112) = 15.64, P < 0.001$), than those failing the assessment, whereas the assessment result did not predict which dogs would be transferred to a breed rescue group ($\chi^2_{K-W} (1, 112) = 1.65, P > 0.1$; Fig. 1).

3.2 Post-test behavior issues

Analysis of behavior problems reported within three months post-adopter revealed that the only behavior issue that was significantly more prevalent among dogs receiving C or lower scores in the assessment compared to dogs receiving A or B scores was house soiling ($\chi^2_{K-W} (1, 112) = 18.8, P < 0.001$; Fig. 2). Dogs scoring C or lower were less likely to be reported as having fear and anxiety issues compared to dogs scoring A or B in the assessment ($\chi^2_{K-W} (1, 112) = 7.62, P < 0.01$; Fig. 2) whereas passing or failing the assessment did not predict subsequent reports of human-directed aggression issues, aggression to other pets, or resource guarding (P > 0.1).
3.1 Test-retest reliability

Overall test-retest reliability analysis indicated significant differences in the test and retest scores between shelter 1 and shelter 2 in the Kennel (Wilcoxon matched-pairs signed ranks test: \( W = 3.94, df = 82, P < 0.001 \)), Food (\( W = 3.20, df = 82, P < 0.01 \)) and Object (\( W = 3.41, df = 82, P < 0.001 \)) sub-tests (Fig. 3). There was a positive correlation in scores of tests conducted on the same dogs at shelter 1 and shelter 2 (\( r_S = 0.459, n= 83, P < 0.05 \)). When the assessment was performed within shelter 2, there were no significant differences between test and retest scores in any of the sub-tests (\( df = 31, P > 0.10 \); Fig. 4). There was a positive correlation (\( r_S = 0.411, n = 31, P < 0.05 \)) in scores from the test and retest at shelter 2.

4. Discussion

Our results indicate that the behavior assessment tool used in the adoption transport program demonstrated conclusion validity in terms of indicating whether or not a dog was likely to be placed in an adoptive home and whether a dog was likely to be subjected to euthanasia due to aggressiveness towards humans. These findings are not surprising given that the assessment outcome was used to screen out the most aggressive dogs from being adopted. These dogs were not placed up for adoption due to concern for public safety, because they directed aggressive behavior towards the tester during the assessment. If these dogs also exhibited aggression to shelter personnel during daily care and failed to respond to behavior modification attempts, they were subjected to euthanasia. The euthanasia sample also included adopted dogs that passed the assessment, or failed the assessment only due to resource guarding, that were subsequently returned to the shelter due to owner-report of aggressive behavior towards people.
When considering total owner reports of aggressive behavior, the assessment tool was not a reliable predictor of aggression towards people following adoption, presumably because the most severely aggressive dogs were screened out at the shelter and not put up for adoption. It is also possible that dog owner expectations were influenced by information received at time of adoption. Owners were given information gained while the dog was in residence at the shelter as well as information gained through the behavior assessment. Some owners who adopted dogs known to exhibit resource guarding may have used this knowledge and avoided attempting to recover food or other resources from the dog, therefore eliminating the possibility for that behavior to occur in the home. Some owners may have also instigated behavior modification and training to address potential resource guarding issues. This may explain the overall relatively low rates of aggression and resource guarding reported by owners post-adoption, and lack of differences in these behaviors between dogs passing and failing the assessment.

The assessment tool was predictive of fear and anxiety issues in the home but in the opposite direction to that predicted. We had expected that the assessment tool would screen out dogs exhibiting both defensive and offensive aggression towards people, thus reducing the likelihood of owner-reported fear and anxiety issues in adopted dogs. However, fear- and anxiety-related behaviors were included in the A and B scores for some of the sub-tests, and the test was not designed specifically to rule out adoption for dogs exhibiting these behaviors but, rather, to reduce the risk of adopting out dangerous dogs. Fear and anxiety issues were relatively common among the adopted population, suggesting that the assessment was successful in screening out dogs exhibiting both defensive as well as offensive aggression, resulting in an adopted population more likely to exhibit fear- and anxiety-related behavior in the absence of aggressiveness.
The assessment tool was also, unexpectedly, predictive of house soiling. The reason for this is not clear but may be related to the fact that the failed dogs that were adopted were those that exhibited resource guarding in the food or toy sub-tests. Possibly, the house soiling issues were related to marking behavior. If so, the underlying mechanism common to both resource guarding and marking could be territoriality. This information may be useful to shelter personnel in matching dogs with prospective owners if confirmed.

When attempting to explain relationships identified between the assessment results and subsequent behavior in the home, questions arise regarding the accuracy of owner reports of dog behavior (Diesel et al, 2008). A weakness of the protocol used in the current study was the lack of detailed descriptions of the behaviors asked about in the questionnaire to dog owners. Dog owners may have differed in their interpretation of the questions posed in the follow-up surveys. The questionnaire also did not distinguish between first-time dog owners and experienced dog owners. New dog owners may have difficulty recognizing dog behavioral signals. Tami and Gallagher (2009) found that working with or living with dogs improves human ability to interpret some dog behaviors. For example, non-dog owners often failed to accurately label or interpret canine confidence and play behavior. Lynge and Ladewig (2005) found that dogs responded differently to cues from experienced and inexperienced dog handlers. Thus, first-time dog owners in our study may have given an inaccurate depiction of their dogs’ behavior based on inexperience. Without independent verification of the accuracy of owner reports, it is difficult to validate the predictive power of the behavior assessment performed at the shelters.

There are other human factors that must be considered when relying on owner reports of their dog’s behavior. Dog owners may underreport behavior issues when relinquishing a dog for fear that the shelter will reclaim the dog (although not a shelter policy), that the dog will be
euthanized if they return the dog, or that the shelter will refuse to accept the dog (DiGiacomo et al., 1998; Marston and Bennett, 2003; Stephen and Ledger, 2007). Labeling behavior in the questionnaire as “aggressive to people,” may not have been conducive to receiving reliable information from owners. Furthermore, multiple rating biases have been reported in parental rating of their child’s temperament and behavior that may also be relevant when using owner reports on dog behavior. For example, parental expectations are influenced by their experience with their other children, and parents may rate a child’s temperament as more severe or difficult based on subtle behavioral differences when compared to a sibling. Variables such as sex, birth order, age and spacing also influence parental observations of child behavior when compared to observations made by an unrelated observer (Seifer et al., 1994). Dog owners may be contrasting the adopted dog’s behavior with previously owned dogs or other known dogs, or with their own preconceived expectations, and these factors may influence the accuracy of owner reports. Rothbart and Hwang (2002) suggest that only a multidimensional approach utilizing both parent and observer ratings will yield an accurate depiction of child temperament and this likely applies to evaluation of dog behavior as well.

Hsu and Serpell, (2003) found that certain groupings for owner-reported behaviors could be used to identify temperament traits in dogs. They employed questions concerning common responses to stimuli in the natural environment rather than applying a diagnostic approach, which may force the dog owner to label the behavior. The method described by Serpell and Hsu (2001) and utilized in Hsu and Serpell (2003) is the only dog behavior questionnaire to date that has been shown to reliably measure owner reported behavior. However, the questionnaire used by these researchers contained either 40 items or 68 items. In our study, obtaining owner compliance in responding to requests for follow-up information was a challenge despite using a
much shorter questionnaire. To obtain at least one data point for each dog in the study, we had to combine data obtained at 3 days, 3 weeks, and 3 months following adoption, which was not ideal as dog behavior, and owner perceptions, may have changed over time. Due to variable amounts of data obtained for each dog over the three time points, we were not able to account for changes over time post-adoption in our analysis. In addition, although with persistence we were able to obtain at least some follow-up information from all dog adopters in our sample population, further specificity in requesting information about behavior may have enhanced our ability to interpret the results. For example, it would have been useful to know more precisely what fear- and anxiety-related behaviors were being exhibited, and to obtain a breakdown of house soiling into specific patterns of urination and defecation behavior.

We had predicted that the behavioral assessment would give reliable information regardless of test environment. Although the assessment exhibited test-retest reliability within shelter 2, there was a lack of repeatability between shelters 1 and 2 for three of the six sub-tests. Possible reasons for differences could have included the shorter time between the test and retest for dogs originating at shelter 2, which might also affect tester memory of the outcome of a previous test on the same dog. Ideally, testers would be fully blind to the outcome of previous tests conducted on the same dog but it is not obvious how this might be achieved in a shelter environment. Another reason for differences in outcomes between shelters relates to the longer time that dogs lived at shelter 1 before receiving their first assessment, since familiarity with the test environment could be expected to reduce fearfulness and increase confidence during the test. A related issue is the possibly greater familiarity of testers to the dogs at shelter 1 due to the dogs’ longer stay at the shelter before testing. Differences in test arena sizes used at the two shelters, and differences in the number of dogs in each sample, could also have contributed to
different test outcomes. Furthermore, the terminology in the assessment tool could have been interpreted differently by different testers and observers at different shelters, which could have an unpredictable effect on results given that different testers and observers were involved in the conduct to the assessments and these people were not balanced across dogs. Standardization of behavior assessments used in shelters remains a challenge due to the number of environmental confounds resulting from highly variable testing and housing environments.

For test ratings to be reliable the parameter being studied must be well defined and the observer must be able to discriminate between the parameters. The assessment tool used in the current study had a graded scale which included multiple behaviors within each grade and sub-categories that were not necessarily equally scaled, which may have lead to inconsistencies in application between observers. There may also be bias introduced in using an A-F scale. Although the subcategories of grades (e.g., A1, A2, and A3, etc.) are well defined, observers may have preconceived notions about grades leading to misinterpretation of the intended grade definitions. For instance, A2 is not necessarily worse than A1 but simply represents different behavioral elements than A1. In our study, dogs scoring C or lower in sub-tests were considered to have failed the assessment since this was the cut-off being employed in practice to determine whether dogs were eligible for the shelter transfer program. Further analyses to assess relative power of the full range of grades in predicting successful adoptions may be more fruitful than application of an arbitrary failing score.

Human motivational factors represent another possible source of error in determining the test-retest reliability. Personnel at shelter 1, the transferring shelter, were likely highly motivated to pass along dogs that might otherwise have been euthanized due to lack of space at the shelter. This potential bias might explain the greater number of dogs with A and B scores from shelter 1,
the sending shelter, than shelter 2, the receiving shelter. In addition, the staff at shelter 2 may have been more motivated to detect aggression issues in their dogs so that they could be addressed by behavior modification prior to placing the dogs up for adoption, with the goal of reducing the number of dogs returned by adopters due to behavior problems. The level of training could also have influenced the information gained from the assessment. Shelter 2 is a larger private non-profit urban animal welfare organization that employs a behavior and training staff that undergo extensive training, and personnel at that shelter had been using the assessment instrument for several years prior to this study whereas, despite training, personnel at shelter 1 had less experience in use of the assessment tool. Diesel and colleagues (2008) reported that workers at an animal welfare agency differed in their ability to read dog body language. In three behavior tests, approach a kennel, handling, and meeting another dog, workers with either formal training or over 8 years of experience showed higher inter-rater reliability, suggesting that inter-observer reliability increases with experience and level of training. Future studies should take into account tester experience and type of formal training to develop a more reliable assessment protocol.

5. Conclusions

We found that the behavioral assessment tool used in the current study had conclusion validity in predicting likelihood of adoption and the likelihood of euthanasia for aggression reasons, but we did not detect a link between test scores and overall owner-report of aggressive behavior towards people. Contrary to expectation, dogs receiving higher scores in the assessment were subsequently more, rather than less, likely to exhibit signs of fear and anxiety compared to dogs scoring a C or lower in the assessment. Low scores were, on the other hand,
predictive of future house soiling behavior. Some discrepancies in test-retest scores were
detected, indicating that caution is needed in interpreting results of the assessment. Furthermore,
the accuracy of the owner reports was not verified independently. Validation of behavioral
assessment tools may be improved by introduction of an ethogram for scoring behavior and
implementing a validated questionnaire to owners.

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Fig. 1. Relationship between failing (black bars) or passing (gray bars) a behavioral assessment at the shelter and subsequent outcome for dogs (n=114; Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; *** P < 0.001).
Fig. 2. Behavior problems reported by owners within 3 months post-adoption in dogs (n=114) that failed (black bars) or passed (gray bars) a behavior assessment at the shelter prior to adoption (Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; **P < 0.01, ***P < 0.001).
Fig. 3. Test-retest scores (values 1-7 represent increasing levels of aggressiveness) of dogs (n=83) in sub-tests of a behavioral assessment conducted at Shelter 1 (black bars) and repeated after transfer of dogs to Shelter 2 (gray bars; Wilcoxon matched-pairs signed ranks test; ***P < 0.001).
Fig. 4. Test-retest scores (values 1-7 represent increasing levels of aggressiveness) of dogs (n=31) in sub-tests of a behavioral assessment conducted at Shelter 2. None of the test (black bars) and retest (gray bars) sub-test scores differed significantly (Wilcoxon matched-pairs signed ranks test; P>0.05).
CHAPTER THREE

RELATIONSHIP BETWEEN BEHAVIOR EXHIBITED IN A PRE-ADOPTION BEHAVIORAL ASSESSMENT AND AGGRESSION FOLLOWING ADOPTION IN DOGS SUBSEQUENTLY RETURNED TO AN ANIMAL SHELTER

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Abstract

Existing behavior assessments used to identify problem behaviors in shelter dogs have proven unreliable in predicting aggression towards humans following adoption. These assessments have focused on overt aggressive behavior as the criterion for deeming dogs unadoptable but inclusion of other behaviors signaling either approach or withdrawal may add to the predictive power of these assessments. We retrospectively examined the association between multiple behaviors displayed in a behavioral assessment conducted at an animal shelter prior to adoption and owner-reported behavior of dogs adopted and subsequently returned to the shelter. We predicted that dogs exhibiting more aggression and fear-related behaviors (e.g., shy/cower and lip lick) in the shelter assessment would be more likely to display aggression towards humans following adoption. Dogs that failed the behavior assessment by displaying a freeze/hard eye, growl, snarl, snap, lunge, or bite at the tester were more likely to give bites and threats (growl, snarl and snap) towards strangers (P < 0.05) following adoption than dogs that passed the assessment, as determined from owner report. Higher levels of stiffening and whirling in the assessment were predictive of biting strangers post-adoption (P < 0.05), and higher levels of shy/cower and growl in the assessment were predictive of threats to both strangers and familiar people following adoption (P < 0.05). There was also a tendency for more lip licks in the shelter assessment to be associated with threats to familiar people post-adoption (P = 0.06). Snapping at the tester during the assessment was predictive of being euthanized when returned to the shelter following adoption (P < 0.01). Biting strangers following adoption was associated with a reduced likelihood of being re-adopted, and increased likelihood of being euthanized, following return to the shelter (P < 0.001). Dogs reported to have threatened strangers (P < 0.05), bitten familiar people (P < 0.05), or exhibited resource guarding (P < 0.05),
aggression towards other dogs (P < 0.001) or sickness (P < 0.001), were also more likely to be euthanized following return. The results indicate that, within the subset of adopted dogs that were subsequently returned to the shelter, aggressive behaviors directed toward the tester during the assessment were more predictive of future aggression towards strangers than familiar people. Fear-related behaviors exhibited during the assessment were predictive of threatening behavior directed towards familiar people following adoption, suggesting that their inclusion can increase the reliability of behavior assessments used at animal shelters to identify aggressive dogs.

**Keywords:** Dog, Behavioral assessment, Aggressive behavior, Human-animal interaction

1. **Introduction**

   According to the Centers for Disease Control and Prevention (CDC, 2003), an estimated 129.3 per 100,000 members of the American population sought hospital emergency treatment for dog-related injuries over the course of one year, accounting for approximately 1.1% of all emergency room visits (Weiss et al., 1998). Furthermore, 45% of children in one survey reported having been bitten by a dog (Beck and Jones, 1985). These figures highlight the public safety concerns arising from aggressive behavior in dogs. An estimated 77.5 million dogs currently live in American households, of which 19% were adopted from animal shelters (American Pet Products Association, 2010). Behavior problems are the most commonly reported reasons for returning dogs to a shelter (Salman et al., 2000), accounting for 26-30% of returns (Salman et al, 1998; Wells and Hepper, 2000). In a study at 12 American shelters, dog bites and other forms of aggression towards people were among the top ten reasons given by owners for relinquishment
of their dog (Salman et al., 2000). Accurate identification of dogs likely to be aggressive post-adoption could aid shelter personnel in deciding on appropriate dog placements, thereby reducing the risk of aggressive incidents, improving owner satisfaction, and reducing the number of adopted dogs returned to shelters.

Shelters have been implementing behavior assessment tools to assist in identifying behavior problems that might be problematic post-adoption, and in an attempt to apply objective criteria to the classification of dogs as suitable or unsuitable for adoption (Bollen and Horowitz, 2008). Few of these assessment tools have been evaluated for their effectiveness in achieving these goals. Christensen et al. (2006) found that 41% of dogs that passed a shelter behavior assessment were reported by owners to show some form of aggression in the new home post adoption. Bollen and Horowitz (2008) reported that, of dogs that passed a shelter behavioral assessment and were subsequently adopted, those that exhibited mild aggression (stiffening, slight growling) during the test were more likely to be returned due to aggression than those exhibiting no behavior problems during the test, or a lack of social responsiveness to the tester. Of dogs that failed the test due to display of more severely aggressive responses (growling, lunging and attempting to bite), over 95% were euthanized for public safety reasons and a lack of resources for implementing intensive behavioral modification of these dogs (Bollen and Horowitz, 2008).

Anticipating the reactions of a dog to stimuli likely to be encountered post adoption depends on properly recognizing and classifying expressive behaviors exhibited by dogs when challenged with these stimuli in a behavioral assessment (Lindsay, 2000; Scott and Fuller, 1965). What may complicate the detection of dangerous dogs is conflict between aggressiveness and fearfulness (Lorenz, 1966), such that the dogs do not exhibit overt attack behavior during the test.
but show signs of both threat and withdrawal. Assessing both offensive and defensive behaviors occurring during behavioral assessment may, therefore, be informative in predicting the risk of aggression to humans post adoption.

The goal of this retrospective study was to evaluate relationships between: (1) behavior displayed by dogs in a shelter behavior assessment prior to adoption, (2) owner-reported aggressive behavior of these dogs 3 to 6 months post adoption, (3) owner-reported reasons for return of these dogs to the shelter within one year post-adoption, and (4) outcome for the dog following return (euthanasia or kept for re-adoption). Specifically, we sought to identify behavior in the test that predicted return to the shelter post-adoption due to human-directed aggression. Our sample included dogs that exhibited agonistic behavior in the behavior assessment but were, nevertheless, deemed adoptable due to small size. We predicted that dogs exhibiting agonistic and fear-related behaviors in the behavior assessment prior to adoption would be more likely to be returned to the shelter due to owner-reported aggression towards humans than dogs exhibiting no signs of aggression or fear in the assessment.

2. Materials and methods

2.1 Subjects

We studied the records of 168 dogs that were adopted from, and subsequently returned to, a large urban shelter over a two-year period (different from those in the study described in Chapter 2). Prior to adoption, the dogs had been assessed with a behavior assessment tool developed by the shelter personnel to determine suitability of dogs for adoption. Follow-up
information was successfully obtained from the owners of 79 of these “adopted and returned” dogs, 3 to 6 months following adoption of the dog and before its return to the shelter.

2.2 Behavior assessment at the shelter before adoption

Behavior assessments were administered to all dogs entering the shelter, 24 to 72 hours after arrival at the shelter. They were performed in a large open training room (15 m x 30 m) within the shelter. The assessments were performed by a trained staff member and comprised twelve sub-tests, affiliation, food, high value object, basic petting, tail pull, four paws, ears, teeth check, restraining hug, skin grab, collar grab and pull, and manners test, performed in that order (Appendix B). A model human hand (Assess-A-Hand®, Great Dog Productions LLC, Accord, NY) was used in place of the tester’s hand during the food, high value object and petting sub-tests if the dog showed signs of aggression in the preceding sub-test(s). A trained observer circled all behaviors that occurred in each sub-test of those listed on the scoring sheet for that sub-test (Appendix B), as called out by the tester. Several different individuals were involved as testers and observers over the course of the study. The assessment ended when all sub-tests were completed, in which case the dog was classified as having passed the assessment. The assessment was terminated early if the dog failed the assessment by performing a freeze/hard eye, growl, snarl, snap, lunge, or bite.

The behaviors recorded are described in Table 1. Evaluation of the dog’s responses was based on 1-0 sampling of each behavior in each sub-test (either present or absent), summed across all sub-tests. Thus, a dog could receive a score ranging from 0 to a maximum of 12 for each behavior, depending on the total number of sub-tests in which that behavior was listed as a
possible response. The food guarding behaviors in the food sub-test, including body block, accelerated eating, decelerated eating, cessation of eating and muzzle punching, occurred too rarely for analysis (data not reported).

2.3 Owner-reported aggression in follow-up following adoption

Three to 6 months following adoption of each dog from the shelter, a member of the shelter’s behavior and training department attempted to contact the owner by phone, e-mail, or mail. Respondents were asked about their dog’s behavior in the new home, with questions about the dog’s response to situations such as interactions with familiar people and strangers. For each of the following categories, we assigned a score of 1 or 0 according to whether or not the dog was reported to exhibit the behavior: bites to familiar people (FB), bites to strangers (SB), threats (snap, snarl, growl) to familiar people (FT), and threats to strangers (ST). These categories were not mutually exclusive.

2.4 Returns

Data were collated for all dogs that were adopted and then relinquished back to the same shelter within one year of adoption, deemed returned dogs. Behavior and training department staff members at the shelter solicited information from owners at the time of return of these dogs, using both a relinquishment form and a face-to-face interview, to obtain information about the dog’s behavioral history in the home. The relinquishment form listed the following reasons: moving, not enough time, new baby, illness in family, allergies to dog, unable to commit to dog,
landlord issues, dog aggressive towards familiar people, dog aggressive towards strangers, dog aggressive towards other dogs, resource guarding, barking, dog has too much energy, destructive, house training issues, dog too shy, resident pet upset by dog, dog health issues, separation anxiety, and other reasons. The owner was asked to select all reasons that applied to their situation. Based on owner response on the form, the face-to-face interview was used by the shelter staff member to clarify reasons for return of the dog, including any reason not listed on the form. For each return reason, the dog was given a score of 1 or 0 according to whether or not the owner reported that reason.

If potentially re-adoptable based on owner-reported behavioral and health history, returned dogs were re-evaluated with the behavioral assessment (data not reported). All records on the returned dogs were examined by shelter staff to determine the ultimate outcome for the dog (euthanasia or put up for re-adoption).

2.5 Statistical analysis

All statistical analyses were conducted using NCSS (2000) software. We employed the Kruskal-Wallis one-way analysis of variance on ranks, corrected for ties, to investigate the following relationships, based on retrospective analysis: (1) passing or failing (displaying a freeze/hard eye, growl, snarl, snap, lunge, or bite) the assessment versus forms of aggression (FB, SB, FT, and ST) reported by owners on follow-up post adoption, (2) rate of performing each behavior in the shelter pre-adoption behavior assessment versus forms of owner-reported aggression (FB, SB, FT, and ST) post adoption, (3) rate of performing each behavior in the pre-
adoption assessment versus outcome for the dog after return (re-adoption or euthanasia), and (4) reasons given by owners for return of the dog versus outcome for the dog after return (re-adoption or euthanasia).

3. Results

In the two-year period prior to implementation of the behavior assessment at the shelter, the return rate for adopted dogs (n of all dogs returned to the shelter per year/n of all dogs adopted from the shelter per year) was 29.6%. In the first year after adoption of the behavior assessment, the return rate was 15%.

Based on owner report in response to questions asked by shelter personnel in the follow-up conducted 3 to 6 months after adoption of dogs, the dogs that failed the behavior assessment at the shelter were subsequently more likely to give bites ($\chi^2_{K-W}(1, 77) = 8.85, P < 0.01$) and threats ($\chi^2_{K-W}(1, 77) = 5.05, P < 0.05$) to strangers, but not bites ($\chi^2_{K-W}(1, 77) = 1.01, P = 0.314$) or threats ($\chi^2_{K-W}(1, 77) = 0.51, P = 0.473$) to familiar people, than dogs that passed the assessment.

Compared to returned dogs that were reported by owners to be non-aggressive towards people post adoption (NA), those that bit familiar people (FB) showed more orienting to the tester ($P < 0.001$) and less avoidance ($P < 0.01$) behaviors (Fig. 5), those that bit strangers post-adoption (SB) showed more snap ($P < 0.001$), whirl ($P < 0.05$), and stiffen ($P < 0.05$) behaviors (Fig. 6), those that threatened (growled, snarled and/or snapped) familiar people (FT) performed more growl ($P < 0.01$) and shy/cower ($P < 0.05$) behaviors (Fig. 7), and those that threatened
strangers (ST) tended to perform more lip licking (P < 0.10), and performed more growl (P < 0.05), and shy/cower (P < 0.01) behavior and less standing (P < 0.05) behavior (Fig. 8) in the pre-adoption assessment (Table 2).

Dogs that snapped in the assessment (χ²_K-W (1, 77) = 4.38, P = 0.036) were more likely to be euthanized after return to the shelter compared to non-aggressive returned dogs. Analysis of information from the post-adoption follow-up revealed that dogs that had bitten familiar people (χ²_K-W (1, 77) = 8.93, P < 0.01), bitten strangers (χ²_K-W (1, 77) = 20.83, P < 0.001), or threatened strangers (χ²_K-W (1, 77) = 6.40, P < 0.05) were more likely to be euthanized after return compared to non-aggressive returned dogs.

Analysis of the return reasons given by owners at the time of relinquishment revealed that dogs reported to be aggressive towards familiar people (P < 0.001), aggressive towards strangers (P < 0.001), aggressive towards other dogs (P < 0.001) and exhibiting resource guarding (P < 0.05) were more likely to be euthanized rather than put up for adoption after return (Table 3).

4. Discussion

Overall failure of the assessment was predictive of future aggression towards strangers but not familiar people. Failing the assessment was contingent upon performance of overtly aggressive behaviors including freeze/hard eye, growl, snarl, snap, lunge and bite. When considered individually, snapping was the only behavior in this list that occurred in enough dogs to be significantly predictive of biting strangers following adoption. However, whirling, and stiffening of the body in the assessment were also predictive of biting strangers, suggesting that they should be added to the list of behaviors resulting in an assessment failure verdict. Consistent
with these findings, Bollen and Horowitz (2008) reported that dogs that showed mild aggression, including stiffening of the body, in a behavior assessment were more likely to be returned to the shelter for aggression. Growling was the only individual behavior in the “failing” list that was significantly predictive of threatening strangers, and was also predictive of threatening familiar people.

It is perhaps not surprising that assessment failure due to the performance of overtly aggressive behavior was predictive of aggression towards strangers given that assessments were performed by an unfamiliar tester within 3 days of arriving at the shelter. These conditions can be expected to favor detection of offensive aggressive behavior towards strangers in the most confidently or habitually aggressive dogs, possibly exacerbated by housing in isolation during an initial quarantine period after arrival at the shelter. The assessment was not specifically designed to simulate other contexts in which aggressive behavior can occur, including aggression towards familiar members of a household, predatory aggression, or intra-specific aggression (Christensen et al., 2006). This is an overall weakness of behavior assessment of dogs at shelters (Diederich and Giffroy, 2006), where an evaluation soon after arrival is favored to enable dogs to be made available for adoption without delay. At this time, known people are not available to perform the assessment. Nevertheless, dogs reported to bite familiar people following adoption were more likely to orient towards the tester, and less likely to avoid the tester, than non-aggressive dogs suggesting that, although more inhibited than those that subsequently bit strangers, biting dogs were, in general, more confident than non-biting dogs.

There were other behaviors that, although not overtly aggressive, were predictive of future human-directed threats. Reminiscent of the resident-intruder paradigm demonstrated in a variety of mammalian species (D’Eath, 2002; Nelson and Trainor, 2007), dogs with a tendency
to be aggressive could be predicted to respond as intruders rather than residents in the assessment when suddenly confronted with an unfamiliar tester in an unfamiliar location, exhibiting defensive rather than offensive aggression. Consistent with this explanation, dogs subsequently reported to threaten strangers and familiar people were more likely to shy and cower, and growl, in the assessment than non-aggressive dogs, and those that threatened strangers also tended to lip lick more. Performance of these behaviors suggests that the dogs were highly aroused, in a state of conflict between fear and aggression, and attempting to avoid further confrontation. If these attempts to maintain a safe distance were ineffective, the dog could resort to more overtly aggressive behaviors. In a classic study of canine agonistic displays, Lorenz (1966) found that they occurred on a continuum between aggression and fear, and often contained elements of both, as reflected in facial expressions. That work supports our assertion that attention to both threat behaviors, and fear-related and withdrawal behaviors, when conducting behavior assessments is fruitful for estimating the risk of future aggression towards both familiar and unfamiliar people.

Although not previously studied as a precursor to aggression, lip licking has been associated with avoidance behaviors such as looking away or avoiding a stimulus (Aloff, 2005). Beerda and colleagues (1998, 1999) found that dogs subjected to stressful stimuli such as spatial restriction, forcing the dog to the ground, or a startle from a suddenly opening umbrella or falling bag, exhibited high levels of oral behaviors including lip licking when a human was present but not when humans were absent. Lip licking was one of the behaviors investigated in the classic work of Scott and Fuller (1965) as a component of emotional reactivity, which they defined as a change in emotional behavior over course of exposure. They discovered that lip licking decreased with age and repeated exposure to handling and aversive stimuli (shock).
Avoidance behavior has previously been linked to aggression to strangers (Appleby et al., 2002; Bollen and Horowitz, 2008). Appleby and colleagues (2002) found that avoidance behavior is influenced by non-maternal rearing environments and lack of socialization experience. Dogs with reported aggression to unfamiliar humans had a lack of experience within a litter and in the rearing environment. They observed that the greatest level of aggression shown by fearful dogs was targeted towards guests entering the home (Appleby et al., 2002). Svartberg (2002) found that social interest towards a human was negatively related to aggression whereas fear of strangers, measured by avoidance, was positively related to aggression. In another study of behavior traits, based on owner responses to a questionnaire, responses related to sociability were negatively related to stranger-directed fear and stranger-directed aggression (Serpell and Hsu, 2001).

Subtle threat behavior requires further examination. Dogs that were reported to show aggression toward familiar people displayed more orienting to the handler and growling in the assessment compared to dogs reported to show no aggression to familiar humans. Orienting to the handler may be a subtle threat behavior. Frontal orientation and an upright posture are signs of aggression that are lower on the fear scale described by Lorenz (1966). Aggressive dogs may be more likely to face the handler in this manner as a signal of aggression, suggesting that subtle behaviors such as orientation may prove helpful in predicting aggression to familiar people. However, orienting to the handler can occur in different contexts. Assessments may be improved by differentiating between orienting to the handler in a solicitous versus threatening manner.

Growling in the behavior assessment was indicative of future aggression directed toward both strangers and familiar people. Faragó and colleagues (2010) noted that dogs growled when
approached by a stranger. In acoustical analysis, they detected differences between agonistic growls and growls given in a play context. Acoustic analysis of dog vocalizations may, thus, be a useful addition to behavioral assessment if it can be automated for practical application at shelters. Although tail wagging was not associated with future aggression in our study, attention to subtleties in the form of tail wagging exhibited in assessments may be warranted. Quaranta and colleagues (2007) noted decreased amplitude of tail wagging when dogs were presented with an unfamiliar human compared to their owner, and when presented with a potentially threatening dog, they showed a left side bias in tail wagging as opposed to a right side bias in other contexts. This bias may represent differential activation of brain regions responsible for withdrawal or approach, respectively. Other behaviors such as growls may represent similar differences in underlying motivation.

Owner reports of reasons for relinquishment did not appear to be as accurate when the information was given in a face-to-face interview as opposed to a more anonymous mail or email report. This is consistent with the findings of Segurson and Serpell (2005), who noted that the most reliable information came from anonymous reports. Dogs identified in a shelter as aggressive are likely to be put to death and owners relinquishing dogs may not wish to report aggression for this reason. Therefore, the information obtained face-to-face from owners surrendering their dogs may not have been as informative as the information gathered in the post-adoption follow-up questionnaire that was completed remotely.

Dogs that snapped on the assessment were more likely to be euthanized after return. Snapping is described as air biting and is often viewed as an intentional miss. It is a threat behavior and is associated with bites when the aggressive behavior escalates. We also found that dogs were more likely to be euthanized if returned with owner reports of human aggression, dog
aggression, resource guarding, and sickness. Other than sickness, these behaviors are risky to the
dog owner, difficult to manage and not likely to be tolerated by other adoptive owners. Shelter
workers performing assessments are faced with the daunting task of selecting dogs for adoption
and conversely, selecting dogs for euthanasia. They are likely to be predisposed to under-
evaluate mild threat behaviors and fear behaviors as predictors of aggression in the home.

5. Conclusions

Identification of individual behaviors through behavior assessment provides more robust
information about a dog’s propensity to bite or threaten humans than a pass or fail scoring on a
behavior assessment. Examination of fear and approach/withdrawal behaviors in addition to
threats of aggression may help to identify dogs with a predilection to escalate to biting behavior
outside of the testing environment.

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<table>
<thead>
<tr>
<th><strong>Behavior</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body blocking</td>
<td>Dog positions body between handler and food bowl; changes position to limit handler access to food bowl</td>
</tr>
<tr>
<td>Accelerated eating</td>
<td>Dog increases rate of consuming dog food when approached during any portion of food sub-test</td>
</tr>
<tr>
<td>Decelerated eating</td>
<td>Dog decreases rate of consuming dog food when approached during any portion of food sub-test</td>
</tr>
<tr>
<td>Cessation of eating</td>
<td>Dog stops consuming dog food when approached during any portion of food sub-test</td>
</tr>
<tr>
<td>Muzzle punch bowl</td>
<td>Dog thrusts muzzle with mouth closed and makes brief but forceful contact of muzzle with bowl</td>
</tr>
<tr>
<td>Muzzle punch Assess-A-Hand</td>
<td>Dog thrusts muzzle with mouth closed and makes brief but forceful contact of muzzle with fake human hand testing tool</td>
</tr>
<tr>
<td>Multiple bites/shakes</td>
<td>Dog open mouth and closes it aggressively and makes contact with handler or fake human hand testing tool</td>
</tr>
<tr>
<td>Solicit</td>
<td>Dog decreases distance to handler/maintains attention on handler for 5 s/makes physical contact with handler for 5 s</td>
</tr>
<tr>
<td>Stand</td>
<td>Dog is in upright position on all four feet</td>
</tr>
<tr>
<td>Sit</td>
<td>Dog is in a reclined position with hind legs bent and hind quarters resting on floor</td>
</tr>
<tr>
<td>Lay down</td>
<td>Dog is in recumbent position with side or ventral surface on ground</td>
</tr>
<tr>
<td>Roll over</td>
<td>From recumbent position with side or ventral surface on ground, dog rolls onto back</td>
</tr>
<tr>
<td>High amplitude tail wag</td>
<td>Dog moves tail back and forth within a lateral plane or in a circular motion with a high frequency of movements and multiple repetitions. Bout ends when tail movement ceases for a minimum of 3 s</td>
</tr>
<tr>
<td>Behavior</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Low amplitude tail wag</td>
<td>Dog moves tail slowly back and forth at least one time within a lateral plane or in a circular motion. Bout ends when all tail movement ceases for minimum of 3 s</td>
</tr>
<tr>
<td>Shy/cower</td>
<td>Dog moves low to the ground and contracts all limbs</td>
</tr>
<tr>
<td>Avoid</td>
<td>Dog recoils or contracts body and/or head (while remaining in the same location) and increases space between its body and handler or handler’s hand</td>
</tr>
<tr>
<td>Pull away</td>
<td>Dog changes location (moves forward or backward) to increase distance from handler; may pull on tether and/or move to maximal length of tether</td>
</tr>
<tr>
<td>Lick handler</td>
<td>Dog places tongue on handler’s hand</td>
</tr>
<tr>
<td>Inhibited mouthing</td>
<td>Dog opens and closes mouth on handler or object (Assess-A-Hand) at least one time without pressure</td>
</tr>
<tr>
<td>Lip lick</td>
<td>Dog’s tongue appears on front of mouth and licks upper lip in a lateral movement</td>
</tr>
<tr>
<td>Pant</td>
<td>Dog breathes with open mouth; tongue may be protruding from mouth</td>
</tr>
<tr>
<td>Stiffen</td>
<td>Dog tenses/flexes muscles</td>
</tr>
<tr>
<td>Freeze</td>
<td>Dog ceases all movement and stiffens/flexes muscles for at least 0.5 s; may hold breath</td>
</tr>
<tr>
<td>Orient to handler</td>
<td>Dog orients head in direction of handler’s frontal plane for at least 0.5 s</td>
</tr>
<tr>
<td>Whirl</td>
<td>Dog quickly/suddenly changes position from facing away from handler to facing towards handler’s frontal plane and orients head towards handler for at least 0.5 s</td>
</tr>
<tr>
<td>Tail tucked</td>
<td>Dog contracts tail muscles, tail is held between rear legs or against abdomen</td>
</tr>
<tr>
<td>Look away</td>
<td>Dog diverts gaze away from handler; avoids eye contact for at least 2 s</td>
</tr>
<tr>
<td>Whine</td>
<td>Dog emits a high-pitched, long-duration vocalization</td>
</tr>
<tr>
<td>Yawn</td>
<td>Dog opens mouth wide while inhaling and closes mouth</td>
</tr>
<tr>
<td>Bark</td>
<td>Dog emits a loud, low or high pitched short; vocalization may include multiple repetitions</td>
</tr>
<tr>
<td>Behavior</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Play bow</td>
<td>Dog bends forelegs so that head and shoulders are low to the ground and hindquarters are elevated</td>
</tr>
<tr>
<td>Slow jaw placement</td>
<td>Dog opens and closes mouth slowly with light pressure on handler’s hand</td>
</tr>
<tr>
<td>Freeze/hard eye</td>
<td>Dog ceases all movement and gives direct prolonged eye contact with the handler lasting a minimum of 3 seconds</td>
</tr>
<tr>
<td>Growl</td>
<td>Dog emits a low frequency rumbling vocalization in throat</td>
</tr>
<tr>
<td>Snarl</td>
<td>Dog retracts lip and exposes canines; may be accompanied by growling</td>
</tr>
<tr>
<td>Snap</td>
<td>Dog opens and closes its mouth in the air; may be accompanied by showing teeth, growling, barking or lunging forward</td>
</tr>
<tr>
<td>Lunge</td>
<td>Dog makes a sudden and drastic move forward in space at least 30 cm</td>
</tr>
<tr>
<td>Bite</td>
<td>Dog opens and closes mouth making contact with moderate to firm pressure on any part of the handler or fake human hand testing tool</td>
</tr>
</tbody>
</table>
Table 2. Retrospective analysis of relationship between owner-reported aggression 3-6 months post-adoption and frequencies of behaviors (based on 1-0 sampling in sub-tests, summed over all sub-tests) exhibited during behavior assessment pre-adoption as compared to frequencies of behaviors exhibited pre-adoption by dogs with no reported aggression post-adoption (Kruskal-Wallis one way ANOVA on ranks, corrected for ties). Data for behaviors with P values >0.1 are not shown.

<table>
<thead>
<tr>
<th>Owner-reported aggression post-adoption</th>
<th>Behavior in assessment pre-adoption</th>
<th>$\chi^2_{K-W}$ (1, 77)</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bite familiar people</td>
<td>Orient to handler</td>
<td>14.20</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Avoid</td>
<td>7.95</td>
<td>0.005</td>
</tr>
<tr>
<td>Bite strangers</td>
<td>Snap</td>
<td>18.99</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Whirl</td>
<td>4.77</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>Stiffen</td>
<td>6.33</td>
<td>0.012</td>
</tr>
<tr>
<td>Threaten familiar people</td>
<td>Growl</td>
<td>9.40</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Shy/cower</td>
<td>3.92</td>
<td>0.047</td>
</tr>
<tr>
<td>Threaten strangers</td>
<td>Lip lick</td>
<td>3.43</td>
<td>0.063</td>
</tr>
<tr>
<td></td>
<td>Growl</td>
<td>9.40</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Shy/cower</td>
<td>8.70</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Stand</td>
<td>4.82</td>
<td>0.028</td>
</tr>
</tbody>
</table>
Table 3. Proportions (mean ± SE) of adopted dogs (n=79) made available for re-adoption or euthanized of those returned to a shelter for various reasons given, as reported by owners (Kruskal-Wallis one way ANOVA on ranks, corrected for ties). Return reasons were not mutually exclusive.

<table>
<thead>
<tr>
<th>Return reason</th>
<th>Available for re-adoption</th>
<th>Euthanized</th>
<th>$\chi^2_{K-W} (1, 77)$</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.09</td>
<td>1.26</td>
<td>0.27</td>
</tr>
<tr>
<td>Not enough time</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.09</td>
<td>1.09</td>
<td>0.29</td>
</tr>
<tr>
<td>New baby</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.02</td>
<td>0.10</td>
<td>0.76</td>
</tr>
<tr>
<td>Illness in family</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.03</td>
<td>0.10</td>
<td>0.76</td>
</tr>
<tr>
<td>Allergies to dog</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.17</td>
<td>0.30</td>
<td>0.58</td>
</tr>
<tr>
<td>Unable to commit to dog</td>
<td>0.1 ± 0.04</td>
<td>0.0 ± 0.00</td>
<td>2.08</td>
<td>0.15</td>
</tr>
<tr>
<td>Landlord</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.14</td>
<td>0.40</td>
<td>0.52</td>
</tr>
<tr>
<td>Aggressive to familiar people</td>
<td>0.0 ± 0.03</td>
<td>0.5 ± 0.08</td>
<td>15.72</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Aggressive to strangers</td>
<td>0.0 ± 0.02</td>
<td>0.6 ± 0.07</td>
<td>31.31</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Aggressive to other dogs</td>
<td>0.1 ± 0.03</td>
<td>0.4 ± 0.09</td>
<td>8.92</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Resource guarding</td>
<td>0.1 ± 0.03</td>
<td>0.5 ± 0.19</td>
<td>4.25</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Barking</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.08</td>
<td>0.51</td>
<td>0.47</td>
</tr>
<tr>
<td>Too much energy</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.11</td>
<td>0.62</td>
<td>0.43</td>
</tr>
<tr>
<td>Destructive</td>
<td>0.1 ± 0.04</td>
<td>0.1 ± 0.08</td>
<td>0.05</td>
<td>0.94</td>
</tr>
<tr>
<td>House training issues</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.12</td>
<td>0.51</td>
<td>0.47</td>
</tr>
<tr>
<td>Too shy</td>
<td>0.0 ± 0.00</td>
<td>0.0 ± 0.00</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Resident pet upset by dog</td>
<td>0.1 ± 0.04</td>
<td>0.1 ± 0.07</td>
<td>0.03</td>
<td>0.87</td>
</tr>
<tr>
<td>Dog health issues</td>
<td>0.0 ± 0.01</td>
<td>0.0 ± 0.04</td>
<td>0.01</td>
<td>0.75</td>
</tr>
<tr>
<td>Separation anxiety</td>
<td>0.1 ± 0.03</td>
<td>0.0 ± 0.16</td>
<td>0.29</td>
<td>0.58</td>
</tr>
</tbody>
</table>
Fig. 5. Relationship between frequency (mean ± SE events per test, based on 1-0 sampling in sub-tests, summed over all sub-tests) of orient to handler and avoid performed by dogs (n=79) in a shelter behavior assessment prior to adoption and owner report of bites to familiar people (FB, black bars) or no aggression (NA, gray bars) in the 3 to 6 months following adoption (Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; **P < 0.01, ***P < 0.001).
Fig. 6. Relationship between frequency (mean ± SE events per test, based on 1-0 sampling in sub-tests, summed over all sub-tests) of snap, whirl, and stiffen performed by dogs (n=79) in a shelter behavior assessment prior to adoption and owner report of bites to strangers (SB, black bars) or no aggression (NA, gray bars) in the 3 to 6 months following adoption (Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; **P < 0.01, ***P < 0.001).
Fig. 7. Relationship between frequency (mean ± SE events per test, based on 1-0 sampling in sub-tests, summed over all sub-tests) of growl and shy/cower performed by dogs (n=79) in a shelter behavior assessment prior to adoption and owner report of threats to familiar people (FT, black bars) or no aggression (NA, gray bars) in the 3 to 6 months following adoption (Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; *P < 0.05, **P < 0.01).
Fig. 8. Relationship between frequency (mean ± SE events per test, based on 1-0 sampling in sub-tests, summed over all sub-tests) of lip lick, growl, shy/cower, and stand performed by dogs (n=79) in a shelter behavior assessment prior to adoption and owner report of threats to strangers (ST, black bars) or no aggression (NA, gray bars) in the 3 to 6 months following adoption (Kruskal-Wallis one way analysis of variance on ranks, corrected for ties; #P < 0.1, *P < 0.05, **P < 0.01, ***P < 0.001).
CHAPTER FOUR

VALIDITY OF A METHOD FOR EVALUATING DOG AGGRESSION TOWARDS HUMANS

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Abstract

Dog bites present a serious public health concern making it desirable to find ways to identify aggressive dogs before they bite. We aimed to validate an assessment for identifying dogs aggressive to humans, adapted from an assessment used by the San Francisco Society for the Prevention of Cruelty to Animals. Based on owner report, dogs (n=42) were assigned to one of four experimental groups: Non-aggressive (no history of bites, growls, snarls, or snaps directed towards humans), Threatening (had previously growled, snarled, snapped, but not bitten, humans), Moderately Aggressive (had previously bitten a human in an aggressive manner without skin puncture), and Highly Aggressive (had previously aggressively bitten a human with skin puncture). We hypothesized that aggressive dogs would be more likely to snap, lunge and bite in the assessment compared to Non-aggressive controls. Dogs were presented individually for testing in an unfamiliar arena, in a random order, to a handler unfamiliar to the dogs. The handler called out behaviors performed by the dog as the assessment progressed, for recording by an observer. Both handler and observer were blind to each dog’s aggression classification. Data analysed using Kruskal-Wallis one way analysis of variance on ranks, corrected for ties, followed by the Kruskal-Wallis Z-test for pairwise comparisons, revealed that dogs in the Moderately Aggressive and Highly Aggressive categories were more likely to lunge than dogs in the Non-aggressive and Threatening categories (P < 0.01). Dogs in the Non-aggressive category showed more looking away than dogs in all other groups (P < 0.05). No dogs in the Non-aggressive category tested positively for aggression (0% false positives) whereas the assessment produced false negative error rates of 82%, 25%, and 36% for dogs in the Threatening, Moderately Aggressive, and Highly Aggressive categories, respectively. However, when considering the value of the assessment for predicting owner-reported aggression in the 12
months post-test, the assessment gave only 20% false positives and 7.4% false negatives, a lower rate of error relative to those previously reported for behavior assessments but nevertheless highlighting the absence of a failsafe method for predicting which dogs present a danger of biting people.

**Keywords:** Dog, Behavioral assessment, Aggressive behavior, Human-animal interaction

1. Introduction

Dog bites represent a serious public health concern. According to data from the National Center for Health Statistics, there were 157 dog-bite related fatalities in the USA from 1979-1988, and 109 fatalities from 1989-1994 (Sacks et al., 1989, 1996). Based on Centers for Disease Control and Prevention data, an estimated 368,245 people, or 129.3 per 100,000 members of the population, were treated in hospital emergency departments for dog related injuries in the USA during 2001 (CDC, 2003), arising from an estimated population of over 50 million pet dogs (Overall and Love, 2001). Other figures in the literature for annual reported dog bite rates per 100,000 members of the population include 4.8 in New Zealand (Langley, 1992), 37.5 in Lyon, France (Chomel and Trotignon, 1992), 73 in Adelaide, Australia (Thompson, 1997), 160 in Guelph, Canada (Szpakowski et al., 1989), 900 in Belgium (Van Eeckhout and Wylock, 2005), and 1900 in Bangalore, India (Sudarshan et al., 2001). In Bangkok, Thailand, 5.3% of injuries seen in emergency rooms were dog bite-related (Bhanganada et al., 1993). Not only are dog bites dangerous due to direct injuries but they are also of concern as they can
transfer deadly infectious pathogens such as rabies virus (Sudarshan et al., 2001; Patronek and Slavinski, 2009).

To minimize dog bite-related injuries and fatalities, it would be desirable to identify dogs that are likely to attack humans before they bite, enabling added precautions to be taken. Behavior assessment may be a good tool for identifying which dogs are likely to bite. The majority of behavior tests on dogs are done in the context of predicting working ability (Jones and Gosling, 2005). For example, Serpell and Hsu (2001) found that a behavioral questionnaire coupled with a behavior test reliably predicted the suitability of dogs for guiding work, and Weiss and Greenberg (1997) reported that behavior testing was a useful tool for predicting fear and submission that would disqualify a dog from an assistance dog program. Behavior assessment can assist in predicting problem behavior in dogs (Bollen and Horowitz, 2007; Ledger and Baxter, 1997; Marder et al., 2003; van der Borg et al., 1991) although standardization across tests is a problem (Diederich and Giffroy, 2006). For example, in a study of shelter dogs, van der Borg et al. (1991) used a behavior test to identify four common behavior problems: aggression, fear, obedience, and separation anxiety. Overall, their test resulted in a 74% probability of predicting problem behaviors in the home.

Use of behavior assessment to forecast aggression, specifically, has proven more challenging (Campbell, 1972; Goddard and Beilharz, 1984, 1986). In van der Borg et al.’s (1991) study, their test had only a 47.4% predictive value for aggression towards adult humans, and a 33.3% predictive value for territorial aggression towards people. In a study at the American Society for the Prevention of Cruelty to Animals, Marder et al. (2003) found that a behavioral evaluation of shelter dogs had 46% predictability for aggression in the home after adoption. In another study, 41% of dogs that passed a behavior test showed some form of
aggressive behavior within 13 months post adoption (Christensen et al., 2006). Behavior assessments can also falsely identify non-aggressive dogs as aggressive. In a test to identify aggressive dogs, Netto and Planta (1997) found that 97% of all dogs tested showed some form of aggression, with 67% of dogs tested reported to show biting or attack behavior during the test. In a study of shelter dogs, 20% of dogs classified as non-aggressive based on owner report were classified as positive for aggression in a standardized behavior test, whereas only 6% of dogs reported by owners to be non-aggressive tested negative for aggression (van der Borg et al., 1991). Bollen and Horowitz (2007) found that 8% of dogs classified as “borderline” (exhibiting mild aggressive behaviors such as stiffening or slight growling when tested at an animal shelter) that were considered available for adoption were euthanized after showing aggression on the adoption floor. The “borderline” classification was also associated with subsequent return of dogs to the shelter due to aggressiveness (Bollen and Horowitz, 2007). Poor predictability of aggression toward humans may result from lack of differentiation of the target of aggression. Aggression to strangers has been predicted by behavior assessment (Planta and De Meester, 2007) but aggression to familiar people may be poorly detected by a test that is administered by an unfamiliar person in a novel environment (Overall, 1997).

Personnel at the San Francisco Society for the Prevention of Cruelty to Animals (SF SPCA) animal shelter in California have been utilizing a behavior assessment since 1999 in an attempt to identify which of the dogs that come into the shelter may be aggressive towards humans. In a survey of 253 dogs that were assessed and then adopted out by the SF SPCA, only eleven dogs (4.4%) showed any incident of aggression with biting within six months after adoption (Donaldson, unpublished data). In the present study, we tested the construct validity of a behavior assessment adapted from that utilized by the SF SPCA. Based on the low error rate in
the survey, we hypothesized that the assessment would reliably discriminate between dogs varying in level of aggressiveness towards humans. We predicted that dogs with a history of biting, as reported by owners in a behavior questionnaire, would demonstrate aggressive behavior (snap, lunge, and bite) in the assessment whereas dogs reported to have no history of biting humans would exhibit no aggressive behavior in the behavior assessment. We also predicted that dogs with a history of aggression to strangers would display more aggressive behaviors than dogs with a history of aggression to familiar humans.

2. Materials and methods

2.1 Questionnaire

Dog owners were mailed a behavior questionnaire to complete prior to behavioral assessment of their dog (Appendix C). The questionnaire developed for this study was adapted from a behavior history form used by the first author to gather information from dog owners seeking behavior consultation for aggressive dog behavior. Owners were asked to fill in responses or select an answer or answers from a multiple-choice questionnaire relating to their dog’s reactions to certain behavioral stimuli. The goal of the questionnaire was to determine the frequency, target and severity of aggression towards people. The questionnaire was a 40-item instrument comprised of background and behavioral history of the dog, incorporating 18 items on aggression (bite, growl, snarl, snap). Questions concerning aggression included the target, frequency, context and severity of the behaviors.
2.2 Subjects

Forty-two owned dogs from various breeds and ranging from one to 13.5 years of age, were included in the study (Table 4). Subjects were recruited via dog trainers and graduates of the SF SPCA Academy for Dog Trainers based in San Francisco, CA. The dog owners had sought the advice of a behavior professional for one or more of a variety of behavior and training issues including house training, separation anxiety, aggression, or general obedience training.

The dogs were assigned to one of four groups based on owner report via the questionnaire (Table 4). Dogs reported to have no history of bites, growls, snarls, or snaps at people were classified as Non-aggressive (n=12). Dogs reported to have growled, snarled, or snapped at people, but not bitten, were classified as Threatening (n=11). Dogs reported to have bitten people in an aggressive manner with no skin puncture were classified as Moderately Aggressive (n=8). Dogs that had bitten people aggressively and caused tissue damage including skin puncture were classified as Highly Aggressive (n=11).

2.3 Behavior assessment

Assessments were administered by an experienced female dog handler, unfamiliar to the dogs, in a test arena (8 m x 5 m) located at a professional dog training facility that was also unfamiliar to the dogs. Dogs were scheduled for testing at least 20 min apart, and were physically and visually isolated from other dogs while at the test facility. The dogs were presented for assessment in a random order and both the tester, and a trained observer who recorded the results, were blind to the aggression classification of the dogs.
To commence an assessment, the dog was brought into the arena on leash by its owner and tethered to a 1.2-m-long plastic-coated wire tie-down in the center of the arena. After a 5-min acclimation period with the owner seated by the dog, the owner was escorted from the arena by an assistant and seated behind a blind from where it was possible to witness the assessment without distracting the dog.

The assessment was a modified form of an assessment employed by the SF SPCA since 1999 for evaluation of adoptability of dogs. The modifications included addition of two sub-tests (stare and command) and elimination of an excitability test deemed potentially unsafe. The resulting assessment was designed for both ease of use and safety of people and dogs, and comprised twelve sub-tests, affiliation, food test, petting, tail grasp, four paws, ears, teeth check, restraining hug, skin grasp, collar grab, command and stare test, conducted sequentially in that order (Appendix D). A model human hand (Assess-A-Hand®, Great Dog Productions LLC, Accord, NY) was used in place of the tester’s hand during the food test and in the petting test if the dog showed signs of aggression in the preceding sub-test(s). Kevlar gloves, and leather sleeves worn under clothing, were used as a safety precaution.

During each sub-test, the tester called out behaviors being performed by the dog, as defined in an ethogram (Table 5). The observer, seated behind a blind, recorded the behaviors as events by sub-test. Behaviors were not mutually exclusive and could occur in conjunction with other behaviors. The observer and tester had practiced the assessment with shelter dogs prior to the study, and refined the ethogram, until scoring of all behaviors reached at least 99% inter-rater concordance.
The assessment ended when all sub-tests were completed, in which case the dog was classified as having passed the assessment. The assessment was terminated early if the dog failed the assessment by performing a bite, or bite attempt defined as a snap or lunge. The assessment duration ranged from 30 to 410 s (Table 4) dependent on the behavior of the dog. At the end of the assessment, the owner entered the arena, leashed and removed the dog.

All assessments were videotaped and video recordings were used to verify behavioral data if there was any disagreement between the tester and recorder. Each behavior in the ethogram was categorized as being present or absent in each sub-test and these 1-0 scores were summed across all sub-tests for analysis. Since one occurrence of snap, lunge, or bite ended the assessment, these behaviors received a total score of either 1 or 0. Food guarding behaviors including body block, accelerated eating, decelerated eating, cessation of eating and muzzle punching were noted but occurred rarely and were not subjected to statistical analysis.

2.4 Follow-up

A twelve-month follow-up was conducted with owners of dogs that participated in the study, with 100% compliance. Study participants responded by mail, e-mail, or telephone, to a behavior questionnaire regarding their dog’s behavior since participating in the assessment. This questionnaire was similar to that distributed prior to the behavior assessment and included questions regarding their dog’s reaction to familiar people, guests to the home, and strangers. Owners were asked to report if their dog had bitten, snapped or lunged at people since the assessment. Dogs reported to display one or more of these behaviors were classified as showing aggression (Table 4).
2.5 Statistical analysis

Statistical analyses were conducted using NCSS (2000) software. We investigated the relationship between aggression category based on owner-report prior to assessment and behavior in the assessment using Kruskal-Wallis one way analysis of variance on ranks, corrected for ties. The Kruskal-Wallis Z-test for multiple comparisons was used for pairwise comparisons of the means. False positive errors (number of dogs that failed the assessment despite being classified as Non-aggressive based on owner report) and false negative errors (number of dogs that passed the assessment that were classified as Threatening, Moderately Aggressive or Highly Aggressive based on owner report), were expressed as a percentage of dogs in these categories. A Kruskal-Wallis one-way analysis of variance on ranks, corrected for ties, was used to determine if the frequency of owner-reported aggressive behavior post-test differed from the frequency of aggression predicted by failure of the assessment. We employed the same statistical method to evaluate the relationship of pre-test classification and post-test classification based on owner report. A Wilcoxon matched-pairs signed ranks test was conducted to investigate the differences between pre-test and post-test categories and Spearman rank correlation was used to measure the degree of association between the pre-test and post-test categories.

3. Results

Analysis of the relationship of dog aggression category assigned pre-test with behaviour in the twelve sub-tests indicated that dogs in the Moderately Aggressive and Highly Aggressive categories lunged more in the assessment than dogs in the Non-aggressive and Threatening
categories (Kruskal-Wallis Z-test for multiple comparisons, \( P < 0.01 \); Table 6, Fig. 9). Dogs in the Non-aggressive and Threatening categories showed more looking away in the assessment than those in the Moderately Aggressive and Highly Aggressive categories (Kruskal-Wallis Z-test for multiple comparisons, \( P < 0.05 \); Table 6, Fig. 10). No dogs in the Non-aggressive category tested positively for aggression (0% false positives) whereas the assessment produced false negative error rates of 82%, 25%, and 36% for dogs in the Threatening, Moderately Aggressive, and Highly Aggressive categories, respectively (Table 7).

When considering the value of the assessment for predicting owner-reported aggression in the 12 months post-test, the test gave 20% false positives (Table 8) and 7.4% false negatives (Table 9). There were significant differences in pre and post-test classifications of aggression categories (\( P < 0.001 \); Table 4) based on owner report. Dogs were categorized in a lesser aggression category post-test (1.62 ± 0.12) compared to pre-test (2.42 ± 0.18; Wilcoxon matched-pairs signed ranks test; \( W = 18.5, df=41, P < 0.001 \)). Nevertheless, there was a strong positive correlation (\( r_S = 0.715, n = 42, P < 0.05 \)) between the pre-test and post-test categories.

All but one dog classified as Moderately or Highly Aggressive and that failed the behavior assessment continued some form of aggressive behavior in the 12 months following the behavior assessment. This Moderately Aggressive dog was tightly managed due to its previous aggressive tendencies. Two dogs classified as Moderately Aggressive and that failed the assessment were euthanized in the 12 months post-test, one for aggressive behavior to a familiar person (Table 8) and the other for excessive anxiety around humans. Neither dog classified as Threatening that failed the assessment exhibited aggression post-test (Table 8). Of the 12 dogs classified Non-aggressive, and 11 dogs classified Threatening or Moderately Aggressive, that passed the assessment, none exhibited aggression post-test (Table 9). Two dogs classified as
Highly Aggressive and that passed the behavior assessment continued to show aggressive behavior post-test, including bites to familiar people in the household, whereas the other two dogs in the Highly Aggressive category that passed the assessment reportedly showed no aggression after the assessment (Table 9).

Based on pre-test owner-report, dogs that failed the assessment (by demonstrating snap, lunge or bite) were more likely to have a history of biting strangers compared to dogs that passed the assessment (P < 0.001; Table 10). A post-test comparison revealed that dogs that failed the assessment were more likely to be reported by owners to show threats (growl, snarl, and snap) to familiar people (P < 0.05; Table 10), and threats (P < 0.01) and bites (P < 0.01) to strangers (Table 10), in the 12 months following testing than dogs that passed the assessment.

4. Discussion

In testing the construct validity of the behavior assessment, the assessment performed relatively well at discriminating between dogs that had exhibited differing levels of aggression toward humans prior to testing. Investigation of discrete behaviors revealed that two behaviors, lunge and look away, were associated with aggression towards humans. As predicted, dogs with a history of bites showed more aggressive lunging behavior than non-biting dogs. Lunge is an element of attack that is typically exhibited prior to snapping and biting (Scott and Fuller, 1965). Given that it is the first behavior in a sequence and that it was a test terminating behavior, lunge may have interfered with the recording of the other terminating behaviors, snap and bite. Contrary to our prediction we did not see more snaps and bites in dogs with a history of aggression to humans.
Dogs that exhibited one of the three failing behaviors (lunge, snap, bite) had less time in the assessment and, therefore, less time to exhibit additional behaviors. The behavior look away was seen most frequently in dogs with no history of biting (Non-aggressive and Threatening). Averting gaze is viewed as a sign of deference (Aloff, 2005; Bradshaw and Nott, 1995). Therefore, we interpreted looking away as deference to the tester and avoiding a threat when the tester stared at or made other eye contact with the dog.

The assessment resulted in no false positives for the Non-aggressive dog category in the assessment, contrary to prior assessments for aggression towards humans in dogs (Marder et al., 2003; Netto et al., 1997; van der Borg et al., 1991). This finding provides evidence of the construct validity of the assessment, in that all Non-aggressive dogs passed the assessment, despite the potentially stressful stimuli to which dogs were exposed in the sub-tests. The Non-aggressive dogs had no reported threats or bites in the 12 months post test. The majority of Threatening dogs passed the assessment. Threat behaviors other than snap and lunge qualified as passing so these dogs may have displayed aggressive threats, but did not escalate to a bite attempt or a bite in the assessment. Bites occur infrequently in social canids (Lockwood, 1995; Mech, 2000) and threatening dogs may use these visual signals to gain access to resources while minimizing the risk of injury occurring when a conflict escalates into biting. The inability of this assessment to differentiate between dogs that would only show threat behavior and those that would escalate to biting is a limitation to the construct validity of the assessment. Inclusion of other behavioral indicators in the assessment, such as fear-related behaviors, approach, and withdrawal, either in the presence or absence of threat behaviors, may help to elucidate which of the dogs that threaten will bite.
The greatest source of error in the assessment was from dogs that were classified as biting, with or without tissue damage that passed the assessment. This assessment fared better compared to the 47.4% predictive value for detecting aggression towards humans found by van der Borg and colleagues (1991), and the 46% predictive value for detecting aggression in the home found by Marder and colleagues (2003), but the error remains a cause of concern. In the dogs that did not display aggressive behaviors in the assessment but had a history of biting, food guarding was an issue. Biting can occur in food competition (Lockwood, 1995). The food test used in our study may not have presented a sufficiently high value resource to evoke bite attempts or bites (Lindsay, 2001).

Another obstacle to assessing the construct validity of the behavior assessment was behavior modification. Behavior modification most likely influenced the assessment results for dogs in the aggression categories that had undergone extensive behavior modification and training since the reported aggressive incident (Tortora, 1983).

Target of aggression may have also been a source for error. Dogs that bite familiar people do not always show aggression to strangers and, in fact, many times this form of aggression does not manifest until the dog is well-established in an environment (Overall, 1997). However, more dogs with a history of aggression to strangers prior to the assessment showed snap, lunge and bite behavior in the assessment compared to dogs that passed the assessment, and dogs that failed the behavior assessment showed threats to familiar people and threats and bites to strangers. The assessment was a more reliable indicator of aggression toward strangers than aggression toward familiar people. Dogs with a history of aggression to familiar humans may not have targeted aggression at the tester because the tester was an unfamiliar person.
The assessment had value for predicting owner-reported aggression in the 12 months post-test, as the test gave only 20% false positives and 7.4% false negatives, a lower rate of error relative to those previously reported for behavior tests. All dogs that had bitten prior to the assessment and failed the assessment continued to show aggressive behavior post-test. Yet, after the assessment many of the dogs were managed in a manner that reduced the chance that the dogs could exhibit aggressive behavior, for example by not giving them access to unfamiliar people. As a result, no biting was seen but owners reported that the dog would show the behavior if given the opportunity.

The reliability of the assessment is indeterminate. In our estimate of test-retest reliability, we found significant differences in pre-test and post-test categorization of aggressive behavior based on owner report. Overall, dogs were classified in a lesser aggression category post-test than pre-test. However, we cannot infer from this that the assessment was not able to consistently measure behavior over time since our measurements were based on owner reports and compounding environmental and human factors. There may be a selection instrumentation threat to the validity causing dog owners to react differently based on the implementation of the assessment. The assessment may have alerted owners to human aggression and, therefore, they may have managed the dogs more cautiously to avoid conflict. In addition, owner reports may not have been fully reliable given, for example, that inexperience or lack of training in dog body language has been shown to affect observer report of behavior (Tami and Gallagher, 2009).

As found by Serpell and Hsu (2001), a behavior test alone is limited in determining future behavior. Hsu and Serpell (2003) have developed a questionnaire that has demonstrable reliability in determining behavior from owner reports. This questionnaire could be implemented along with our behavior assessment to improve categorization of dogs and improve
the assessment reliability. In addition to improving owner information, the assessment could potentially be improved by further investigating behaviors that were not as closely monitored in this study. Fear and approach-avoidance behaviors may provide to solution to determining when a threatening dog will become a dangerous dog.

5. Conclusions

The behavior assessment employed in this study was able to discriminate between non-aggressive and biting dogs with relatively few false negatives, which is desirable when selecting dogs for adoption or conversely for euthanasia. The predictive ability for owner reported aggression in the 12 months post-test was noteworthy. The test gave only 20% false positives and 7.4% false negatives, a lower rate of error relative to those previously reported for behavior tests but nevertheless highlighting the absence of a failsafe method for predicting which dogs present a danger of biting people.

Acknowledgements

The authors thank the San Francisco SPCA for assisting in this research project and for permission to use their behavior assessment. The authors are grateful to dogTEC and Perfect Paws for the provision of their training facilities. The authors thank all of the dog owners and volunteers who participated in the study, and give a special thanks to Lisa Clifton Bumpass for assistance in participant recruitment, data collection, and collaboration on behavior assessment development.
References


Table 4. Male (M) and female (F) dogs classified into four groups based on pre-test owner report: (1) Non-Aggressive, (2) Threatening, (3) Moderately Aggressive and (4) Highly Aggressive, that passed (P) a behavioral test by completing all sub-tests, or failed (F) by displaying snap, lunge or bite (resulting in immediate termination of test), recategorization based on owner report 12 months post-test, and comparison with pre-test classification (Wilcoxon matched-pairs signed ranks test; W = 18.5, df=41, P < 0.001).

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<td>Body blocking</td>
<td>Dog positions body between handler and food bowl; changes position to limit handler access to food bowl</td>
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<td>Dog increases rate of consuming dog food when approached during any portion of food sub-test</td>
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<td>Cessation of eating</td>
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<td>Muzzle punch bowl</td>
<td>Dog thrusts muzzle with mouth closed and makes brief but forceful contact of muzzle with bowl</td>
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<td>Muzzle punch Assess-A-Hand</td>
<td>Dog thrusts muzzle with mouth closed and makes brief but forceful contact of muzzle with fake human hand testing tool</td>
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<td>Multiple bites/shakes</td>
<td>Dog opens mouth and closes it aggressively and makes contact with handler or fake human hand testing tool</td>
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<td>Solicits</td>
<td>Dog decreases distance to handler/maintains attention on handler for 5 s/makes physical contact with handler for 5 s</td>
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<td>Stands</td>
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<td>Sits</td>
<td>Dog is in a reclined position with hind legs bent and hind quarters resting on floor</td>
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<td>Lays down</td>
<td>Dog is in recumbent position with side or ventral surface on ground</td>
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<td>Rolls over</td>
<td>From recumbent position with side or ventral surface on ground, dog rolls onto back</td>
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</tr>
<tr>
<td>Avoids</td>
<td>Dog recoils or contracts body and/or head (while remaining in same location) to move away from handler or handler’s hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Behavior</strong></td>
<td><strong>Description</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull away</td>
<td>Dog changes location (moves forward or backward) to increase distance from handler; may pull on tether and/or move to maximal length of tether</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licks handler</td>
<td>Dog places tongue on handler’s hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibited mouthing</td>
<td>Dog opens and closes mouth on handler or object (Assess-A-Hand) at least one time without pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lip lick</td>
<td>Dog’s tongue appears at front of mouth and licks upper lip in a lateral movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pant</td>
<td>Dog breathes with open mouth; tongue may be protruding from mouth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stiffen</td>
<td>Dog tenses/flexes muscles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freeze</td>
<td>Dog ceases all movement and stiffens/flexes muscles for at least 0.5 s; may hold breath</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orient to handler</td>
<td>Dog orients head in direction of handler’s frontal plane for at least 0.5 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whirl</td>
<td>Dog quickly/suddenly changes position from facing away from handler to facing towards handler’s frontal plane and orients head towards handler for at least 0.5 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tail tucked</td>
<td>Dog contracts tail muscles; tail held between rear legs or against abdomen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looks away</td>
<td>Dog diverts gaze away from handler; avoids eye contact for at least 2 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whine</td>
<td>Dog emits a high-pitched, long-duration vocalization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growl</td>
<td>Dog emits a low rumbling vocalization in throat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bark</td>
<td>Dog emits loud, sharp, vocalizations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snarl</td>
<td>Dog retracts lip and exposes canines; may be accompanied by growling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snap</td>
<td>Dog’s mouth opens and closes in air; may be accompanied by showing teeth, growling, barking or lunging forward</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunge</td>
<td>Dog makes a sudden and drastic move forward in space at least 30 cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bite</td>
<td>Dog opens and closes mouth making contact with handler or object (Assess-A-Hand, bowl, etc) with pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6. Relationship of aggression category (Non-aggressive, Threatening, Moderately Aggressive and Highly Aggressive) assigned based on owner-report pre-test with frequencies of behaviors (mean ± SE, based on 1-0 sampling of events in sub-tests, summed over sub-tests) exhibited during the behavioral assessment (Kruskal-Wallis one way ANOVA on ranks with Kruskal-Wallis Z-test for multiple comparisons, df=3, *P < 0.05).

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Mean ± SE</th>
<th>$\chi^2_{k-w}$</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solicit</td>
<td>3.52 ± 0.96</td>
<td>7.87</td>
<td>0.077</td>
</tr>
<tr>
<td>Stand</td>
<td>3.59 ± 0.79</td>
<td>6.29</td>
<td>0.098</td>
</tr>
<tr>
<td>Sit</td>
<td>1.26 ± 0.25</td>
<td>3.48</td>
<td>0.322</td>
</tr>
<tr>
<td>Lay down</td>
<td>0.40 ± 0.11</td>
<td>9.88</td>
<td>0.095</td>
</tr>
<tr>
<td>Roll over</td>
<td>0.00 ± 0.00</td>
<td>2.23</td>
<td>0.525</td>
</tr>
<tr>
<td>Tail wag</td>
<td>1.90 ± 0.38</td>
<td>3.11</td>
<td>0.374</td>
</tr>
<tr>
<td>Avoid</td>
<td>0.40 ± 0.13</td>
<td>4.24</td>
<td>0.236</td>
</tr>
<tr>
<td>Pull away</td>
<td>0.81 ± 0.17</td>
<td>2.62</td>
<td>0.453</td>
</tr>
<tr>
<td>Lick handler</td>
<td>0.52 ± 0.08</td>
<td>4.62</td>
<td>0.201</td>
</tr>
<tr>
<td>Inhibited mouthing</td>
<td>0.00 ± 0.00</td>
<td>4.57</td>
<td>0.206</td>
</tr>
<tr>
<td>Lip lick</td>
<td>1.09 ± 0.21</td>
<td>2.07</td>
<td>0.557</td>
</tr>
<tr>
<td>Pant</td>
<td>0.24 ± 0.10</td>
<td>4.38</td>
<td>0.222</td>
</tr>
<tr>
<td>Stiffen</td>
<td>0.95 ± 0.21</td>
<td>5.59</td>
<td>0.133</td>
</tr>
<tr>
<td>Freeze</td>
<td>4.76 ± 0.00</td>
<td>2.73</td>
<td>0.434</td>
</tr>
<tr>
<td>Orient to handler</td>
<td>1.14 ± 0.17</td>
<td>6.13</td>
<td>0.050</td>
</tr>
<tr>
<td>Whirl</td>
<td>0.09 ± 0.00</td>
<td>2.32</td>
<td>0.508</td>
</tr>
<tr>
<td>Tail tuck</td>
<td>0.86 ± 0.21</td>
<td>3.49</td>
<td>0.321</td>
</tr>
<tr>
<td>Look away</td>
<td>0.60 ± 0.00</td>
<td>8.54</td>
<td>0.028*</td>
</tr>
<tr>
<td>Whine</td>
<td>0.76 ± 0.19</td>
<td>3.30</td>
<td>0.347</td>
</tr>
<tr>
<td>Growl</td>
<td>0.36 ± 0.12</td>
<td>2.99</td>
<td>0.392</td>
</tr>
<tr>
<td>Bark</td>
<td>0.40 ± 0.14</td>
<td>3.65</td>
<td>0.301</td>
</tr>
<tr>
<td>Snarl</td>
<td>0.12 ± 0.06</td>
<td>5.51</td>
<td>0.137</td>
</tr>
<tr>
<td>Snap</td>
<td>0.24 ± 0.07</td>
<td>4.50</td>
<td>0.211</td>
</tr>
<tr>
<td>Lunge</td>
<td>0.17 ± 0.06</td>
<td>11.32</td>
<td>0.011*</td>
</tr>
<tr>
<td>Bite</td>
<td>0.00 ± 0.00</td>
<td>2.23</td>
<td>0.525</td>
</tr>
</tbody>
</table>
Table 7. Number of dogs in each behavioral category that displayed aggression in the behavioral assessment.

<table>
<thead>
<tr>
<th>Classification by owner report</th>
<th>Dogs (n)</th>
<th>Aggressive in assessment (n)</th>
<th>False + (n)</th>
<th>False – (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-aggressive</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Threatening</td>
<td>11</td>
<td>2</td>
<td>N/A</td>
<td>9</td>
</tr>
<tr>
<td>Moderately aggressive</td>
<td>8</td>
<td>6</td>
<td>N/A</td>
<td>2</td>
</tr>
<tr>
<td>Highly aggressive</td>
<td>11</td>
<td>7</td>
<td>N/A</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 8. Relationship between failure of the behavior assessment and owner-reported aggression 
($\chi^2_{K-W} = 11.44, df=2, P < 0.001$), and aggression-related euthanasia, within 12 months post-test

<table>
<thead>
<tr>
<th>Classification of dogs</th>
<th>Failed assessment (n)</th>
<th>No aggression post-test (n)</th>
<th>Displayed aggression post-test (n)</th>
<th>Euthanized for aggression post-test(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-aggressive</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Threatening</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moderately aggressive</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Highly aggressive</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 9. Relationship between behavior of dogs that passed the behavioral assessment and owner-reported aggression \( \chi^2_{\text{K-W}} = 12.76, df=3, P < 0.01 \), and aggression-related euthanasia, within 12 months post-test

<table>
<thead>
<tr>
<th>Classification of dogs</th>
<th>Passed assessment (n)</th>
<th>No aggression reported post-test (n)</th>
<th>Displayed aggression post-test (n)</th>
<th>Euthanized for aggression post-test (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-aggressive</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Threatening</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moderately aggressive</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Highly aggressive</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 10. Pre-test and post-test analysis of target (familiar people or strangers) of owner-reported biting and threatening behavior (growl, snarl, snap) exhibited by dogs that failed the behavior assessment (Kruskal-Wallis one way ANOVA on ranks with Kruskal-Wallis Z-test for multiple comparisons, $df$=2).

<table>
<thead>
<tr>
<th>Dogs (n) that failed test</th>
<th>Owner-reported behavior</th>
<th>Target of aggression</th>
<th>Mean ± SE</th>
<th>$\chi^2_{K-W}$</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pre-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Bite</td>
<td>Familiar person</td>
<td>0.47 ± 0.08</td>
<td>2.63</td>
<td>0.105</td>
</tr>
<tr>
<td>7</td>
<td>Threaten</td>
<td></td>
<td>0.47 ± 0.13</td>
<td>2.63</td>
<td>0.105</td>
</tr>
<tr>
<td>12</td>
<td>Bite</td>
<td>Stranger</td>
<td>0.80 ± 0.11</td>
<td>25.64</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>3</td>
<td>Threaten</td>
<td></td>
<td>0.20 ± 0.11</td>
<td>0.82</td>
<td>0.365</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bite</td>
<td>Familiar person</td>
<td>0.13 ± 0.09</td>
<td>1.31</td>
<td>0.251</td>
</tr>
<tr>
<td>3</td>
<td>Threaten</td>
<td></td>
<td>0.40 ± 0.13</td>
<td>24.67</td>
<td>0.031*</td>
</tr>
<tr>
<td>4</td>
<td>Bite</td>
<td>Stranger</td>
<td>0.27 ± 0.12</td>
<td>7.76</td>
<td>0.005**</td>
</tr>
<tr>
<td>9</td>
<td>Threaten</td>
<td></td>
<td>0.60 ± 0.13</td>
<td>8.99</td>
<td>0.003**</td>
</tr>
</tbody>
</table>

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$
Fig. 9. Relationship between aggression category (assigned based on pre-test owner report) and frequency of lunging (1-0 sampling of events in sub-tests, summed over sub-tests) in the behavior assessment (a, b denote differences (P < 0.05) in Kruskal-Wallis Z-test for multiple comparisons)
Fig. 10. Relationship between aggression category (assigned based on pre-test owner report) and frequency of looking away (1-0 sampling of events in sub-tests, summed over sub-tests) in the behavior assessment (a, b denote differences at $P < 0.05$ in Kruskal-Wallis Z value test for multiple comparisons)
GENERAL DISCUSSION

This project was designed to examine the complexities involved in detecting human-directed aggression in dogs. Whilst some limitations were identified in behavioral assessment aimed at predicting some forms of aggression, several noteworthy contributions were made to the understanding of dog non-verbal communication. These include: (1) behaviors other than threat behaviors are relevant for predicting dog bites, (2) dogs exhibit different signs prior to directing aggression towards familiar versus unfamiliar people, and (3) human factors influence the reliability of testing and must be taken into account when performing dog behavior assessments. These findings point to ways of improving behavioral assessment in sheltered dog populations to recognize and predict dog bites.

Measurement of behaviors other than threat

Behavior assessments used in dogs focus primarily on threat behavior as a basis for predicting aggression towards humans (Bollen and Horowitz, 2007; Marder 2003; Netto and Planta 1997; van der Borg et al., 1991). My findings indicate that measurement of threat behavior alone gives an unreliable prediction of biting in dogs but that measurement of behavior displayed in conjunction with or in the absence of threat behavior can improve the predictability of behavior assessment.

Displays of avoidance behavior such as shy/cower (Appleby et al., 2002), or avoidance and withdrawal behavior (Beerda et al., 1998), have been associated with human-directed aggression to strangers in dogs. The behavior shy/cower is similar to the low posture described by Beerda and colleagues (1998) that, along with restlessness and oral behaviors, was
representative of stress indicative of the propensity of a dog to attack, inflicting injury. In agreement with these findings, my results revealed that dogs that shied away or cowered in the assessment were reported by owners to show threat behavior to both familiar and unfamiliar people. In addition, dogs reported to show threats to strangers tended to display the oral behavior, lip licking. Fox and Stelzner (1966) argued that approach and withdrawal behavior in dogs is reflective of human socialization and that latency of approach to humans is lower in dogs with a high motivation to socialize with humans. In all three of my studies, unwillingness to approach or socialize with the tester was associated with behavior issues or return to the shelter. Measuring the reluctance of shelter dogs to approach humans may give insights into the internal motivation of the dog or an indication of prior social bonding with humans (Appleby et al., 2002; Haverbeke et al., 2010; Overall, 1997). These indicators of fear and anxiety should be considered in conjunction with threats when establishing adoptability criteria and in the screening for risk behaviors through behavior assessment.

Avoidance has previously been associated with human-directed aggression to strangers but not familiar people (Appleby, 2002). Conversely, I found that orienting to the handler was greater in dogs with a history of biting familiar people, suggesting that orienting to the handler may represent a behavior competing with avoidance. This form of aggression has been difficult to predict but further investigation into direct frontal orientation may signal the propensity of dogs to bite familiar people.

Behaviors that have not previously been fully explored may identify dogs that would be less prone to biting behavior. The behavior, avoid, in this study was improperly named and represented moving away from the handler, particularly in the handling portions of the tests, rather than unwillingness to approach. Dogs that displayed the behavior, avoid, were more likely
to increase distance either through escape or agonistic displays rather than escalating to a bite. Averting of gaze was seen more in dogs with no historical reports of aggression. A closer examination of this behavior may confirm that averting the gaze represents a reduced likelihood of aggression in dogs. In a close examination of tail wagging, Quaranta and colleagues (2007) found that a right side bias in tail wagging may be associated with approach and a left side bias in tail wagging may be associated with withdrawal. Behavior such as averting of gaze (look away) and avoid, two behaviors shown in non-aggressive dogs in my studies, may signal propensity to retreat or withdrawal as opposed to bite.

My results indicate that dogs that show threats including growls, snarls and snaps may not bite. The identification of threat alone was not a determinant of biting in dogs post-assessment. Dogs reported by owners to show threat behavior but no bites had the highest rate of false negatives when their behavior was assessed. These dogs displayed shying away and cowering, growling and a tendency to lip lick.

Dogs that bit strangers showed stiffening, whirling and snapping and dogs that bit familiar people where differentiated by their lack of fear behavior and the presence of direct frontal orientation. These findings suggest that assessing these behaviors in conjunction with threat behaviors will lead to more reliable prediction of which dogs will bite post-assessment.

**Target of aggression (familiar human vs. unfamiliar human)**

Threat behavior should also be studied in the context of the target of aggression. Dogs that failed the assessment showed threats, but not necessarily, bites to familiar people but displayed both threats and bites to strangers. Dogs that had bitten familiar people prior to the
assessment and passed the assessment continued to bite familiar people after the assessment whereas dogs that showed threats and bites to strangers had failed the assessment. A weakness of behavior assessment is that failure of the assessment is solely defined by overt threats to the tester. Logically, dogs exhibiting aggression to strangers will be over-represented by this methodology and dogs likely to direct aggression to familiar people will go undetected.

The greatest concern derived from this study is the inability to detect aggression in dogs that had a history of biting, especially towards familiar people. A problem with these assessments along with other behavior assessments currently utilized is that they are performed by people unfamiliar with the dog, usually in an unfamiliar location shortly after arrival at the shelter. Many dogs that exhibit aggression towards familiar people do not do so until the dog is in the home for a period of time (Overall, 1997). Retesting by the same tester after some time at the shelter may help to reveal the level of risk of future aggression towards familiar people. Klausz and colleagues (2009) found that repeated behavior assessments resulted in higher scores for aggression when the tester attempted to remove a bone. However, this response may be more indicative of food guarding behavior resulting from group housing with conspecifics at the shelter rather than aggressiveness towards people. One possibility of getting a familiar person to assess a dog in a shelter is to have relinquished dogs handled by the dog owner in an assessment or portion of an assessment. This would give a more accurate representation of aggression to familiar humans. However, if owners rarely report aggression when relinquishing dogs (Marston and Bennett, 2003), they may be unwilling to comply with such a request. In addition, if the target of the dog aggression is a familiar human, it may not be safe to place that person in a situation that could provoke biting. Expanding the duration of behavior tests may allow for some habituation to the test conditions, facilitating the emergence of behavior predictive of aggression.
towards familiar people. However, if this form of aggression is not evidenced for months or even years in a home, depending on the age of the dog and the development of social maturity (Overall, 1997), a single test is unlikely to be predictive of this behavior. Given the restrictions to assessment for this form of aggression, future work should focus on behaviors such as direct frontal orientation.

**Human factors in assessment**

This collection of studies highlights some human factors that may hinder the ability of behavior assessments to predict human-directed aggression. One weakness in the development and implementation of the behavior assessments used in these studies was the description of the behavior to be studied. Over the course of three studies, I found that the use of discrete, well-defined behaviors was superior to a collection of behaviors on a graded scale.

In addition to accurate definition of behavior, behavior must be observable to the tester. Humans may not be as skilled at reading non-verbal communication compared to dogs. Dogs are efficient readers of human communicative gestures (Hare and Tomasello, 2005; Miklosi, 2008; Vas et al., 2005), human facial expressions and gaze (Gràci et al., 2004; Viranyi et al., 2008). Dogs also appear to be able to respond to the attentional state of humans (Call et al., 2003). Humans may not be as efficient as dogs in this ability. Experience in dog handling has been found to significantly affect how the dogs respond to a human. Dogs working with experienced handlers (several years of experience) have been shown to respond to human cues for desirable behaviors more often than the dogs handled by people with minimal training in dog behavior (Lynge and Ladewig, 2005). Dogs also pay less attention to unskilled or inexperienced handlers.
(Lynge and Ladewig, 2005). Many assessments are done in a shelter setting where there is overcrowding, employee turnover and any number of other confounds to the reliability of behavior assessments in the prediction of aggressive behavior. The skill level of testers and implementation of the behavior assessment is a notable confound in studies of predictability of aggression. Diesel and colleagues (2008) found that shelter staff experienced a low to moderate level of agreement on dog behavior assessment results but that agreement was greater among evaluators with higher levels of training and experience. Future studies will require stricter controls over the training and experience level in persons giving the assessments.

Assessments performed in shelters or rescue organizations may also be influenced by the motivation of the person performing the assessment. Employee evaluators may form emotional bonds to a dog and be influenced to score the dog more favorably in the assessment or may not observe unfavorable behaviors due to the social attachment. Breed and size bias are also factors influencing the validity of behavior assessment. Evaluators may be influenced to score an individual of a certain breed less favorably based on negative experiences with other individuals of that breed. Size bias is also at issue when determining validity of behavioral assessment. Many shelters will waive regulations for adoptions for especially small dogs because of the perceived lack of damage threat. There is also a high demand for small dogs and a smaller supply compared to large dogs at shelters. There is motivation to have small dogs pass the assessment given that there are adoptive homes available. In my studies, I did not find that breed or size was a significant factor. Due to the extreme variability in dog breeds and imprecise identification of breed inherent in shelter populations this was not a significant factor however a larger or better defined sample of dogs may reveal effects of size and breed bias.
Shelter workers are also faced with the ethical dilemma of euthanizing a dog that is deemed unfit for adoption. This may influence testers to score a dog more favorably. Although this has not been directly studied in shelter staff, dog owners who relinquish dogs to shelters rarely report aggressive behavior because it may reduce the dog’s chance for survival (Marston and Bennett, 2003). In the reliability study in chapter one, evaluator ratings were more favorable in the first test at a sending shelter compared to the retest at the receiving shelter. The first shelter is motivated to have dogs perform more favorably on assessment so that the dog may participate in the adoption transfer program. Conversely, the receiving shelter is motivated to identify any issues that would make adoption difficult since they are responsible for placement of the dog in a home. Shelter worker observations have been shown to be less reliable than results of behavior assessment (van der Borg et al., 1991) given that workers are motivated to represent dogs more favorably. I suggest that human motivational factors may be influencing the validity of behavior assessment but more work is needed to quantify these motivational factors and develop assessment tools that take these factors into account.

Another obstacle in determining the validity of a behavior assessment is the ability of dog owners to provide optimal information regarding behavior of pet dogs. Van der Borg and colleagues (1991) found that dog owners tended to rate behaviors of pet dogs more favorably compared to the behavior observed by testers during a behavior test. In a study of dog owner reported behavior problems, none of the 72 owners that reported aggression over removing an object or food reported this as a problem behavior. Dog owners may also over-report behavior issues, including aggression as justification for relinquishment of the dog (Stephen and Ledger, 2007). Segurson and colleagues (2005) found that dog owners were not reliable in classifying or accurately reporting dog behavior issues upon relinquishment at an animal shelter. Human
preconceptions and motivations need to be addressed when gathering reported information. In human studies of social perception of hostile behavior, parents’ evaluations of their children’s behavior are biased by factors such as number of siblings, sex of the child, birth order and experience in parenting (Leffert et al., 2010). Therefore, evaluations of children’s’ behavior is taken from not only parent report but also by a trained observer. Dog behavior assessment may be improved by gaining more accurate owner reports of behavior as well as observations from the behavior assessment.

Factors such as attachment level have been shown to influence owner described pet behavior. Serpell (1996) found that people who reported weaker attachment levels for their pets were less satisfied with most aspects of the dog’s behavior. Very attached dog owners rated their pets as more intelligent whereas moderately attached dog owners were less satisfied with all aspects of the dog’s behavior. Owner expectations of dog behavior have a strong influence on the owner perception of dog behavior. Similar to the human studies, when a parent has expectations of one child based upon a sibling or other experience in parenting, their ratings are more severe (Saudino, 2003). Results of these studies similarly suggest that information from multiple sources should be used when evaluating a dog to predict aggressive behavior.

Inexperience and lack of education about dog behavior may result in a decreased ability of dog owners to accurately classify pet dog behavior (Diesel et al, 2008). Dog behavior is often misunderstood and overly influenced by emotion and anthropomorphism (Overall, 1997; Tami and Gallagher, 2009). In a study of human ability to accurately define dog behavior, Tami and Gallagher (2009) found that simply working with or living with dogs without any theoretical knowledge of canine behavior does not result in accurate descriptions of dog behavior.
Serpell and Hsu (2005) have developed an owner questionnaire that has been shown to gather information that is more reliable from dog owners. This questionnaire (C-BARQ) is readily available and has been shown to be reliable in describing aggressive responses in dogs compared to observations by a behavior consultant (Hsu and Sun, 2010; Serpell and Hsu, 2005; van den Berg et al., 2010). This questionnaire is far more comprehensive than the questionnaire used in these studies. However, the CBARQ is comprised of 152 items, which may be excessively long for owners to complete for relinquishment purposes or for adopter follow-up. The participants in the CBARQ validation study (Hsu and Serpell, 2003) were highly motivated pet owners that had sought advice from behavior consultants. The study participants in Chapter Four were drawn from a similar population of motivated owners. The compliance among this group far exceeded the compliance shown by adopters or people relinquishing dogs to the shelter. The questionnaire in Chapter Four may be as reliable on the determination of aggression as the CBARQ. I found that the reliability of the owner assessment of dog aggression remained somewhat stable over a year with dogs initially categorized as moderately aggressive or highly aggressive remaining aggressive. All but one dog that was previously categorized as highly aggressive was re-categorized as moderately aggressive in the one year follow-up questionnaire. Items the questionnaire used in Chapter Four were very similar to the CBARQ, asking owners to rate or list dogs’ responses to situations known to provoke certain forms of aggression. The validity of the CBARQ is based on the analysis of owner reported information on the CBARQ questionnaire compared to a diagnosis made by behavior consultant. Both sources of information are from the owner so the two samples are not independent.

The extensive range of information captured by the CBARQ makes it a superior source of owner information given that owner compliance can be achieved. Because of the difficulty in
compliance inherent in shelter populations it would be best to create a questionnaire with a sub-set of questions similar to those contained in the CBARQ for future analysis of fear and anxiety to supplement the assessment used for the study of aggressive behaviors from Chapter Four. Future work in assessments should utilize the CBARQ questionnaire to improve the accuracy of owner reported dog behavior in conjunction with behavior assessment.

Given time and resources, I would like to expand my research on behavior assessment to focus more directly on canine body language and the signaling of aggressive behavior. I would also like to further investigate the sub-tests on the assessments to determine if certain sub-tests should be eliminated, such as the toy sub-test or portions of the body handling sub-test, whereas others should receive greater focus, such as the affiliation test and the reaction to tester.

While my studies were successful in highlighting some of the perceivable behaviors associated with predicting aggressive attacks, they also revealed that we only understand a small proportion of what a dog is expressing. Future work should focus on approach and withdrawal or avoidance behaviors as well as threat. These behaviors may give a better understanding of the underlying cognitive processes of the dog. Future work is needed on child-directed human aggression. Children are the most common victims of dog bites (Sacks et al., 1998). Work with owner-reported child-aggressive dogs may reveal predictors of these attacks. Lastly, human factors are a notable area for future research. Human factors in assessment have not been reliably evaluated in behavior assessment studies. Dogs may be responding to unintentional signals from the handler. Dogs have been shown to be responsive to not only human gestures but facial expression and gaze (Call et al., 2003; Gácsi et al., 2004; Viranyi et al., 2008), indicating that we need to be cognizant of the social interplay between human and dog.
There is a great need to develop a more reliable tool to predict aggression and an even greater need for standardization of behavior assessments in the sheltering community. This work reveals that more detail analysis of elements of dog non-verbal communication and how they are influenced by humans will enhance the current state of behavior assessment of aggression to humans and help to reduce the risk of dog bites to humans.
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APPENDIX

A. BEHAVIOR ASSESSMENT TOOL – STUDY 1

Date: _______________ Dog’s # and Name: ______________________

Evaluator: ______________________

Step 1 Kennel Observation

Grade A: Dog is at the front of the kennel with a relaxed body, full body wag or tail is moving in a circle wag or below spine wag. Dog may play bow. Dog may jump up on kennel but the dog does this and stays up for you to pat him, does not jump up and down repeatedly. Little to no vocalizations. If vocalizing, dog is whining or crying. Note if the dog takes treat.

Notes: __________________________________________________________________

Grade B1: Dog is at the front of kennel with a relaxed body, jumping up on kennel front in a loose manner, dog may vocalize, and the bark is friendly in tone (bark is high pitched and mouth is open and relaxed). Dog’s tail is wagging below spine level if above spine level the wag is slow and easy. Dog may also show some anxious behavior may slide sideways to you presenting his belly. Note if the dog takes treat.

Notes:

Grade B2: Dog is at the front of the kennel attempting to solicit attention from you, or dog is at back of kennel with a loose low body posture. The dog may move its body to a sideways position as you enter. Dog may exhibit some signs of fearful behavior when you go to enter kennel or at the kennel front. Dog may retreat briefly but comes back to you when spoken to with a low body, ears back, tail down but wagging, eyes are soft. Dog responds to a gentle voice. Dog may submissively urinate or grin at greeting. Note if dog takes treat.

Notes:
Grade C1: Dog is highly aroused but not stiff, dog is barking loudly and slamming his body against the kennel front, dog may also surf up the side walls of the kennel. Dog’s tail is high, ears are up, dogs body is frontal to you and he cannot settle down. Dog’s mouth is open, note if dog has stress wrinkles at the corner of the mouth. Gentle voice seems to have no effect on behavior. Dog is difficult to leash, repeatedly jumping on you may also be grabbing at your clothing, difficult to remove and return to the kennel. Note if the dog will take treat.

Notes: ______________________________________________________________________

Grade C2: Dog is fearful in kennel instead of moving towards you the dog chooses to retreat to the back of the kennel often in a sideways position. Dog’s head is lowered pupils are dilated, closed tight mouth. If dog is at the back of the kennel when approached dog chooses to stay sideways to you, body is stiff or dog will not get up to greet you. Dog may or may not growl or alert bark. Gentle voice seems to have no effect on behavior. Note if dog takes treat:

Notes: ______________________________________________________________________

Grade D: Dog jumps up on the kennel in a stiff manner, alert barks or growls at you; dog continues behavior until you leave. Dog’s mouth is closed, lips are short unless barking. Dog’s tail is high above his spine; his ears are forward his eye is hard. Dog does seem to be comforted by a soft voice. Note if dog takes treat:

Notes: ______________________________________________________________________

Grade F: Dog is not fearful and is stiff and holding eye contact with you. Dog will stand its ground in the kennel. Dog does not respond to gentle voice. Dog may choose to bark or may growl low in the throat. Dog’s mouth is closed tightly the dog’s lip is short even when it is barking. Dog may make an attack attempt as you move away from the kennel.

Notes: ______________________________________________________________________
Step 2 Affiliation Observation

Grade A1: Dog explores the yard, comes to check in with you without being asked. Dog greets you in a loose wiggly greeting, ears back, and eyes soft, body low with tail wagging, mouth is open in a grin. Dog may jump up to give a face greeting (See text for description) once completed do not continue to jump on you. Dog chooses to spend time near you while outside. Dog does not engage in play at all.

Notes: _________________________________________________________________

Grade A2: Dog explores yard, comes immediately to you when called. Dog greets in a loose wiggly greeting, ears back, and eyes soft, body low with tail wagging, mouth is open in a grin. Wanders off quickly once patting stops and may engage in play but loses interest quickly. Whenever called dog will check in, dog is content to explore yard.

Notes: _________________________________________________________________

Grade A3: Dog explores yard, is exuberant, bouncy and running all over yard. Greets you either jumping around you or on you with a soft body, tail low and wagging, ears back, mouth is open in a grin. Dog immediately engages in the game but loses interest in the toy and seeks attention from you instead.

Notes: _________________________________________________________________

Grade B1: Dog explores yard, is exuberant, bouncy and running all over yard. Greets you either jumping around you or on you with a soft body, tail low and wagging, ears back, mouth is open in a grin. When engaged with toy, dog turns game into keep away.

Notes: _________________________________________________________________

Grade B2: Dog explores yard, dog is aroused, hackles may be up, tail is high or dog fearful, tail and body low. After a few minutes, dog becomes more comfortable, no longer piloerect. Dog comes when asked and may engage in play but does not show arousal around play.

Notes: _________________________________________________________________
Grade C1: Dog explores yard, is exuberant, running all over yard. Greets you by jumping on you, body is stiff when jumping on you. Immediately moves away after jumping on you. Mouth tends to be kept open. When engaged in play dog becomes aroused, does not settle when assessor stops game, may take clothing in mouth.

Notes: ________________________________________________________________

Grade C2: Dog explores yard in a confident manner. Dog chooses to not make any social contact with you. Despite repeated calls dog keeps distance from you. Dog may race by and may also choose to body slam you or clip you from behind, as soon as contact is made the dog moves away from you. May or may not engage in toys, may choose keep away.

Notes: __________________________________________________________________

Grade D: Dog explores yard in a fearful manner, ears drawn, head low, back, tail down or tucked. Ridges of tension may be around mouth and eyes, whale eye (see book for definition) is also possible, eyes and nose are facing the direction of the person the body is not. Dog moves around the parameter of the fence, looking for escape options, if on lead dog is always at the end of the leash. Dog will not come to you, when you approach dog, dog may choose to lie down and look away from you or freeze in position.

Notes: __________________________________________________________________

Grade F: Dog explores yard in a stiff manner, walking with tail held high over body, ears forward. When dog faces you holds eye contact, eyes are open not squinty it may be possible to see his tail between his ears. When asked to come to you the dog approaches stiffly and is tall. The dog may become still and mouth may close when you pat the dog.

Notes: __________________________________________________________________
Step 3 Reaction to Tester (In Room)

Grade A1: Dog explores the room, comes to check in with you without being asked. Dog greets you in a loose wiggly greeting, ears back, and eyes soft, body low with tail wagging mouth is open in a grin. Dog may jump up to give a face greeting (See text for description) once completed does not continue to jump on you. Dog chooses to spend time near you.

Notes: _________________________________________________________________

Grade A2: Dog explores room, comes immediately to you when called. Dog greets in a loose wiggly greeting, ears back, and eyes soft, body low with tail wagging, mouth is open in a grin. Wanders off quickly once patting stops, whenever called dog will check in. Dog is content to explore room.

Notes: __________________________________________________________________

Grade B1: Dog explores room, is exuberant, bouncy. Greets you either jumping around you or on you with a soft body, tail low and wagging, ears back, mouth is open in a grin. Dog is busy and doesn’t settle down, seeks attention from you off and on.

Notes: __________________________________________________________________

Grade B2: Dog comes to handler either when asked or unsolicited, body is low and feels soft. Dogs ears are back and tail is down, dog is panting and anxious inside. Sudden noises or activity may cause the dog to show some fear, but dog seeks support from you. Dog may whine.

Notes: __________________________________________________________________

Grade C1: Dog explores room in an exuberant manner. Greets you by jumping on you, body is stiff when jumping on you. Immediately moves away after jumping on you. Mouth tends to be kept open.

Notes: __________________________________________________________________
Grade C2: Dog explores room in a confident manner. Dog chooses to not make any social contact with you. Despite repeated calls dog keeps distance from you. Dog may also choose to body slam and/or muzzle punches you, as soon as contact is made the dog moves away from you. Dog is very tall, appears to be walking on tiptoes. Dog may also choose to lie down in front of door and not move despite repeated encouragement from tester.

Notes:________________________________________________________________________

Grade D: Dog is fearful, ears drawn head low, back, tail down or tucked. Ridges of tension may be around mouth and eyes, whale eye (see book for definition) is also possible, eyes and nose are facing the direction of the person the body is not. Dog chooses to be at the end of the leash, looking for escape options, Dog will not come to you, when you approach dog, dog may choose to lay down and look away from you or freeze in position.

Notes:________________________________________________________________________

Grade F: Dog explores room in a stiff manner, walking with tail held high over body, ears forward. When dog faces you holds eye contact, eyes are open not squinty it may be possible to see his tail between his ears. When asked to come to you the dog approaches stiffly and is tall. The dog may choose to get up on your lap and stand up stiffly on you. The dog may become still and mouth may close when you stroke the dog.

Notes:________________________________________________________________________

Step 4 Food Bowl- Resource Guarding

No Test: Dog has been tested two times, the second time with higher value food such as meat baby food mixed in with the kibble. If you provided a higher value food immediately and the dog still didn’t eat, test again the following day. Dog has shown no interest in food.

Notes:________________________________________________________________________
Grade A1: Dog stops eating, lifts head and allows food to be removed. Body is loose, tail is a sweeping wag, dog’s mouth is open, and ears are neutral or back.

Notes:____________________________________________________________________

Grade A2: Dog allows food to be moved, may follow the dish but lifts head when hand is pushed against face. Body is loose, ears are back, and tail is wagging at or below spine level.

Notes:____________________________________________________________________

Grade B: Dog follows the dish with great interest his tail down and his ears are back, may wag tail faster. It may be difficult to push face out of bowl. Dog does not freeze, appear to stand on tiptoe or stiffen at any time.

Notes: _________________________________________________________________

Grade C: Dog accelerates his consumption (eating faster and taking bigger bites) when asked for his food. He may move to the front of the bowl as you approach. Tail is not wagging. Dog may freeze or stiffen when the hand touches him.

Notes: _________________________________________________________________

Grade D: Dog freezes and growls at any time over the food. Does not lift his head but watches you from the corner of his eye.

Notes: _________________________________________________________________

Grade F: Dog bites the assess-a-hand.

Notes: _________________________________________________________________
Step 5 Toy Test – Resource Guarding

Grade A1: Dog shows no interest in toys.
Notes: ____________________________________________________________

Grade A2: Dog picks up toys and is loose and wiggly attempts to engage you in play with them.
Notes: ____________________________________________________________

Grade A3: Dog picks up toy and either sits or lays down by you to enjoy it. Dog is not stiff and
does not freeze.
Notes: ____________________________________________________________

Grade B: Dog plays keep away with the toy. Dog is loose and wiggly, no freezes or stiffness
observed.
Notes: ____________________________________________________________

Grade C: Dog takes toy and has a firm hold on toy. His body is stiff and he may freeze when
you approach or ask for the toy and he may choose to get under the chair if small enough.
Notes: ____________________________________________________________

Grade D: Dog growls over toy.
Notes: ____________________________________________________________

Grade F: Dog bites.
Notes: ____________________________________________________________
Step 6 Body Handling Assessment

Tug slightly on the collar. Repeat.

Begin to pet the dog with slow methodical strokes from the top of this head to the base of his tail, repeat three or four times.

Touch and look inside both ears

Look at the dog’s teeth for 5 seconds, 5 times in a row.

Attempt to pick up each foot and wipe with towel.

Grade A: Dog remains loose and wiggly throughout and enjoys touch. Dog may lean into you with body, the body feels soft. Dog’s tail is wagging at or below spine level. Ears are neutral, eyes are soft. Dog may attempt to lick your hand. Dog solicited more attention when you stopped.

Notes: ___________________________________________________________________

Grade B1: Dog stands still and accepts touch during the exam. Dog is soft to the touch but not leaning in to you. Dog may be wagging tail below spine level or holding tail below spine level. Ears are neutral, dog may lip lick. Dog does not freeze during the exam.

Notes: __________________________________________________________________

Grade B2: Dog may try to lay down throughout exam. Dog may roll over, paw at handler and try to exit from the handling. Dog’s ears are back and dog may lip lick. Dog may whine during exam. Dog does not freeze or become stiff or still.

Notes: __________________________________________________________________

Grade C: Dog struggles fiercely and does not allow portions of the exam. Dog is loose; tail is at or above spine level. Dog may have some stress wrinkling around mouth or eyes. Dog may repeatedly jump up and off handler.

Notes: __________________________________________________________________
Grade D: Dog is stiff and freezes during portions of the exam, may head flip during portions. Dog may stand up on handler or shoulder roll handler. Dog may attempt to exit. Dog may whale eye at assessor. Dog may muzzle punch handler. Assessment should stop when the dog exhibits this behavior if you continue you risk the dog biting.

Notes: ________________________________________________________________

Grade F: Dog growls or attempts to bite.

Notes: ________________________________________________________________
B. BEHAVIOR ASSESSMENT TOOL – STUDY 2

The San Francisco SPCA Behavior and Training Department

Dog Behavior Evaluation updated 8-30-02

General Instructions:

* If dog is away from shelter for two weeks or more, then a re-evaluation is required

* Re-evaluate whenever a behavior problem is reported

* Shaded areas of the test indicate behaviors that do not meet SF/SPCA Intake and Treatment Criteria

* Additional trials of any portion of the test may be completed at the trainer’s discretion

Date:____________________

Dog’s Name:________________________

Source:__________________

Breed:____________________________

Source ID#: ____________

Color:____________________________

SF/SPCA ID #: A______________

Circle: Male / Female

Altered? Y / N
Trainer:___________  Initial__________

Recorder:_______  Initial__________

Accept:_______________
Decline:___________________________

_________________________________

Dog Status:  Presenting Issues:
## Affiliation

*Make a forward movement toward the front of the kennel. Circle all that apply:*

<table>
<thead>
<tr>
<th>Lip lick</th>
<th>Stiffen</th>
<th>Play Bow</th>
<th>Tail wag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cower</td>
<td>Panting</td>
<td>Yawn</td>
<td>Tail tucked</td>
</tr>
<tr>
<td>Look Away</td>
<td>Bark</td>
<td>Sit</td>
<td></td>
</tr>
</tbody>
</table>

If dog does not approach (but does not retreat), proceed to next section of test.

---

### Handler Affiliation

*Stand facing the dog and wait for the dog to approach. How long before the dog approaches the handler. Circle all that apply:*

<table>
<thead>
<tr>
<th>Lip lick</th>
<th>Stiffen</th>
<th>Play Bow</th>
<th>Tail wag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cower</td>
<td>Panting</td>
<td>Yawn</td>
<td>Tail tucked</td>
</tr>
<tr>
<td>Look Away</td>
<td>Bark</td>
<td>Sit</td>
<td></td>
</tr>
</tbody>
</table>

If dog does not approach handler or stranger, the dog has not demonstrated affiliation.
**HANDLING**

*(To be completed on tie-down and with Kevlar when necessary – any bite to the handler during the test constitutes a low bite threshold and thus the assessment should immediately be terminated)*

Circle all that apply:

<table>
<thead>
<tr>
<th>Basic petting</th>
<th>Stand or sit</th>
<th>High amplitude tail wag</th>
<th>Low amplitude tail wag</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pet form top of head to tail at least 3 times)</td>
<td>Shy from hand</td>
<td>Pull away/avoid</td>
<td>Lay down/roll over</td>
</tr>
<tr>
<td></td>
<td>Lick handler’s hand</td>
<td>Orient to hand</td>
<td>Inhibited mouthing</td>
</tr>
<tr>
<td></td>
<td>Lip lick</td>
<td>Yawn</td>
<td>Pant</td>
</tr>
<tr>
<td></td>
<td>Stiffen</td>
<td>Orient to handler</td>
<td>Whirl</td>
</tr>
<tr>
<td></td>
<td>Slow jaw placement</td>
<td>Whine</td>
<td>Tail tucked</td>
</tr>
<tr>
<td>Freeze/hard eye</td>
<td>Growl</td>
<td>Snarl</td>
<td></td>
</tr>
<tr>
<td>Snap</td>
<td>Lunge</td>
<td>Bite</td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds:*  
Y / N

<table>
<thead>
<tr>
<th>Tail Pull</th>
<th>Stand or sit</th>
<th>High amplitude tail wag</th>
<th>Low amplitude tail wag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st trial gentle pull,</td>
<td>Shy from hand</td>
<td>Pull away/avoid</td>
<td>Lay down/roll over</td>
</tr>
<tr>
<td>2nd trial more firmly,</td>
<td>Lick handler’s hand</td>
<td>Orient to hand</td>
<td>Inhibited mouthing</td>
</tr>
<tr>
<td>(3 seconds each)</td>
<td>Lip lick</td>
<td>Yawn</td>
<td>Pant</td>
</tr>
<tr>
<td></td>
<td>Stiffen</td>
<td>Orient to handler</td>
<td>Whirl</td>
</tr>
<tr>
<td></td>
<td>Slow jaw placement</td>
<td>Whine</td>
<td>Tail tucked</td>
</tr>
<tr>
<td>Freeze/hard eye</td>
<td>Growl</td>
<td>Snarl</td>
<td></td>
</tr>
<tr>
<td>Snap</td>
<td>Lunge</td>
<td>Bite</td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds:*  
Y / N
**Four Paws**

| | Stand or sit | High amplitude tail wag | Low amplitude tail wag |
| | Shy from hand | Pull away/avoid | Lay down/roll over |
| | Lick handler’s hand | Orient to hand | Inhibited mouthing |
| | Lip lick | Yawn | Pant |
| | Stiffen | Orient to handler | Whirl |
| | Slow jaw placement | Whine | Tail tucked |
| | Freeze/hard eye | Growl | Snarl |
| Snap | Lunge | Bite |

*After test, dog solicits more handling within 5 seconds:*  Y / N

**Ears**

| | Stand or sit | High amplitude tail wag | Low amplitude tail wag |
| | Shy from hand | Pull away/avoid | Lay down/roll over |
| | Lick handler’s hand | Orient to hand | Inhibited mouthing |
| | Lip lick | Yawn | Pant |
| | Stiffen | Orient to handler | Whirl |
| | Slow jaw placement | Whine | Tail tucked |
| | Freeze/hard eye | Growl | Snarl |
| Snap | Lunge | Bite |

*After test, dog solicits more handling within 5 seconds:*  Y / N

**Teeth Check**

| | Stand or sit | High amplitude tail wag | Low amplitude tail wag |
| | Shy from hand | Pull away/avoid | Lay down/roll over |
| | Lick handler’s hand | Orient to hand | Inhibited mouthing |
| | Lip lick | Yawn | Pant |
| | Stiffen | Orient to handler | Whirl |
| | Slow jaw placement | Whine | Tail tucked |
| | Freeze/hard eye | Growl | Snarl |
| Snap | Lunge | Bite |

*After test, dog solicits more handling within 5 seconds:*  Y / N

If the dog is not easily handled in any of the above exercises, abort handling test here.
<table>
<thead>
<tr>
<th><strong>Restraining Hug</strong></th>
<th><strong>Pick-up dogs</strong></th>
<th><strong>Stand or sit</strong></th>
<th><strong>High amplitude tail wag</strong></th>
<th><strong>Low amplitude tail wag</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Shy from hand</strong></td>
<td><strong>Pull away/avoid</strong></td>
<td><strong>Lay down/roll over</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>10 lbs &amp; under</strong></td>
<td><strong>Lick handler</strong></td>
<td><strong>Orient to hand</strong></td>
<td><strong>Inhibited mouthing</strong></td>
</tr>
<tr>
<td><strong>(5 seconds)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lip lick</strong></td>
<td><strong>Yawn</strong></td>
<td><strong>Pant</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Stiffen</strong></td>
<td><strong>Orient to handler</strong></td>
<td><strong>Whirl</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Slow jaw placement</strong></td>
<td><strong>Whine</strong></td>
<td><strong>Tail tucked</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Freeze/hard eye</strong></td>
<td><strong>Growl</strong></td>
<td><strong>Snarl</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Snap</strong></td>
<td><strong>Lunge</strong></td>
<td><strong>Bite</strong></td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds: Y / N*

<table>
<thead>
<tr>
<th><strong>Skin Grab</strong></th>
<th><strong>Scruff grab 3 sec.</strong></th>
<th><strong>Stand or sit</strong></th>
<th><strong>High amplitude tail wag</strong></th>
<th><strong>Low amplitude tail wag</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Shy from hand</strong></td>
<td><strong>Pull away/avoid</strong></td>
<td><strong>Lay down/roll over</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lick handler’s hand</strong></td>
<td><strong>Orient to hand</strong></td>
<td><strong>Inhibited mouthing</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lip lick</strong></td>
<td><strong>Yawn</strong></td>
<td><strong>Pant</strong></td>
<td></td>
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<td><strong>Snap</strong></td>
<td><strong>Lunge</strong></td>
<td><strong>Bite</strong></td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds: Y / N*

<table>
<thead>
<tr>
<th><strong>Collar Grab and Pull</strong></th>
<th><strong>Grab collar, with 3 sec. pull</strong></th>
<th><strong>Easily led by collar</strong></th>
<th><strong>High amplitude tail wag</strong></th>
<th><strong>Low amplitude tail wag</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Pull away/avoid</strong></td>
<td><strong>Resist being led by collar</strong></td>
<td><strong>Lay down/roll over</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lick handler’s hand</strong></td>
<td><strong>Orient to hand</strong></td>
<td><strong>Inhibited mouthing</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lip lick</strong></td>
<td><strong>Yawn</strong></td>
<td><strong>Pant</strong></td>
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<td><strong>Stiffen</strong></td>
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<td></td>
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<tr>
<td></td>
<td><strong>Slow jaw placement</strong></td>
<td><strong>Whine</strong></td>
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<td><strong>Snap</strong></td>
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<td><strong>Bite</strong></td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds: Y / N*
<table>
<thead>
<tr>
<th>Manners Test</th>
<th>Stand or sit</th>
<th>High amplitude tail wag</th>
<th>Low amplitude tail wag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowded petting,</td>
<td>Pull away/avoid</td>
<td>Shy from hand</td>
<td>Lay down/roll over</td>
</tr>
<tr>
<td>Clumsy petting,</td>
<td>Lick handler’s hand</td>
<td>Orient to hand</td>
<td>Inhibited mouthing</td>
</tr>
<tr>
<td>Squeaky voice</td>
<td>Lip lick</td>
<td>Yawn</td>
<td>Pant</td>
</tr>
<tr>
<td>5 second duration</td>
<td>Stiffen</td>
<td>Orient to handler</td>
<td>Whirl/ orient to handler</td>
</tr>
<tr>
<td></td>
<td>Jumps on handler</td>
<td>Whine</td>
<td>Tail tucked</td>
</tr>
<tr>
<td>Freeze/hard eye</td>
<td>Growl</td>
<td>Snarl</td>
<td></td>
</tr>
<tr>
<td>Snap</td>
<td>Lunge</td>
<td>Bite</td>
<td></td>
</tr>
</tbody>
</table>

*After test, dog solicits more handling within 5 seconds: Y / N*
Please complete this questionnaire and return to the above address prior to your dog(s)’ behavior assessment date. If you are unable to return the form prior to this date you may bring the form with you to the assessment station on your assigned assessment date.

Date: ________________

Name(s):___________________________________________________________

Address: ______________________________________________________________________

Home Phone: ________________ Work Phone: ____________________________

Cell Phone: ______________________ E-mail_______________________________

Other Contact #(s):__________________________________________________________

DOG INFORMATION

Dog’s name: ____________________________________________________________

Breed ______________________________ Color_______________________________

Age____________________ Date of Birth______________________________

□ Male □ Female     Neutered/Spayed Yes □ No □ At what age in months?__________

Has your dog been bred? _______ if so, when?___________________________

How old was your dog when you first acquired him/her? _________________

Where did you acquire your dog? _______________________________________

Please list your dog’s medical conditions:

Please list any medications and/or herbal supplements your dog is taking:
Where is your dog kept?

a) During the day_______________________________________________________

b) During the night_____________________________________________________

c) When it is alone_____________________________________________________

d) When guests visit____________________________________________________

Is your dog (please check all that apply):

- □ allowed to run free, unsupervised
- □ allowed in a fenced yard
- □ allowed in a kennel/run
- □ allowed to be leash walked
- □ allowed outside, unleashed but supervised
- □ allowed chained or tethered outside

List the members of the household:

<table>
<thead>
<tr>
<th>Name (first name only)</th>
<th>Sex (M/F)</th>
<th>Age (Years)</th>
<th>Relationship (self, husband, wife, daughter, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

List other pets that share the household:

<table>
<thead>
<tr>
<th>Name</th>
<th>Species (dog, cat, etc)</th>
<th>Breed</th>
<th>Sex (M/F)</th>
<th>Age</th>
<th>Altered (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Why did you choose this breed?

Why did you choose this specific animal?
Have you owned a dog before?   Yes □  No □

Have you owned this breed before?   Yes □  No □

What is your dog's obedience training history (check all that apply)?
□ no or limited training
□ no formal school/Trained yourself
□ puppy class
□ group lessons-basic
□ group lessons-advanced
□ private trainer

At what age did your dog begin training? ____________________

Who took your dog to classes or, if not taken to classes, who has done most of your dog’s training? __________________________

Has your dog bitten (made contact) you, any member of your household?   Yes □  No □

Please list members of household that the dog has bitten (made contact):

Has your dog growled, barked, snarled, or snapped at you or household member?   Yes □  No □

Please list members of the household at which your dog has growled, barked, snapped or snarled:

Has your dog bitten guests to your home?   Yes □  No □

Has your dog growled, snapped, snarled or barked at guests to your home?   Yes □  No □

Has your dog bitten strangers?   Yes □  No □

Has your dog bitten other dogs?   Yes □  No □

Number of total bites your dog has given to people (made contact)
□ 0 □ 1-2 □ 3 □ 4 □ 5 or more

Number of bites to people in which teeth touched, but no puncture.
□ 0 □ 1-2 □ 3 □ 4 □ 5 or more

Number of bites to people that broke the skin (1-4 holes from a single bite)
□ 0 □ 1-2 □ 3 □ 4 □ 5 or more
Number of bites to people that broke the skin with deep puncture (up to 1.5 times the depth of a single canine tooth)

□ 0 □ 1-2 □ 3 □ 4 □ 5 or more

How does your dog react to petting on the head (check all that apply)?
□ sits or lays quietly
□ moves away from your hand
□ barks
□ snarls
□ growls
□ bites
□ other (describe): _______________________________________

How does your dog react to petting on the back and shoulders (check all that apply)?
□ sits or lays quietly
□ moves away from your hand
□ barks
□ snarls
□ growls
□ bites
□ other (describe): _________________________________

How does your dog react to petting on the belly (check all that apply)?
□ sits or lays quietly
□ moves away from your hand
□ barks
□ snarls
□ growls
□ bites
□ other (describe): _________________________________

How does your dog react when you ask him/her to move from a resting place (check all that apply)?
□ gets up and walks away immediately
□ gets up after repeated commands and moves away
□ barks
□ snarls and remains
□ growls and remains
□ bites and remains
□ other (describe): _________________________________
How does your dog react when you handle his/her feet (check all that apply)?
- □ gets up and walks away immediately
- □ gets up after repeated commands and moves away
- □ barks
- □ snarls and remains
- □ growls and remains
- □ bites and remains
- □ other (describe): ____________________________

How does your dog react when you handle his/her mouth (check all that apply)?
- □ gets up and walks away immediately
- □ gets up after repeated commands and moves away
- □ barks
- □ snarls and remains
- □ growls and remains
- □ bites and remains
- □ other (describe): ____________________________

How does your dog react when you take a toy away from him/her (check all that apply)?
- □ gives up toy immediately
- □ gives up toy after repeated commands
- □ barks
- □ snarls and keeps toy
- □ growls and keeps toy
- □ bites and keeps toy
- □ other (describe): ____________________________

How does your dog react to when you take food away from him/her (check all that apply)?
- □ readily gives up bowl
- □ gives up food bowl after repeated attempts
- □ barks
- □ snarls
- □ growls
- □ bites
- □ other (describe): ____________________________

Within the past year, has your dog been treated for any behavior problems?

If so, please describe the course of treatment/behavior therapy that you have been given for your dog (please include medications):
D. BEHAVIOR ASSESSMENT TOOL - STUDY 3

Dog Behavior Assessment

Date: ____________________________
Time: ____________________________

ID#: ____________________________

Breed: ____________________________
Color: ____________________________

Circle: Male / Female  Altered?  Y / N

Tester: ____________________________
Observer: ____________________________

Affiliation

*Tester will stand facing the dog avoiding direct eye contact with dog and sudden movement for 5 seconds. Circle all that apply:*

<table>
<thead>
<tr>
<th>Stand</th>
<th>Sit</th>
<th>Lay down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll over</td>
<td>Tail wag</td>
<td>Avoid</td>
</tr>
<tr>
<td>Pull away</td>
<td>Lick handler</td>
<td>Inhibited mouthing</td>
</tr>
<tr>
<td>Lip lick</td>
<td>Pant</td>
<td>Stiffen</td>
</tr>
<tr>
<td>Freeze</td>
<td>Orient to handler</td>
<td>Whirl</td>
</tr>
<tr>
<td>Tail tucked</td>
<td>Look away</td>
<td>Whine</td>
</tr>
<tr>
<td>Growl</td>
<td>Bark</td>
<td>Snarl</td>
</tr>
<tr>
<td>Snap</td>
<td>Lunge</td>
<td>Bite</td>
</tr>
</tbody>
</table>
Note: A dog that snaps, lunges, or bites, the assess-a-hand or delivers multiple bites to the assess-a-hand at any point during the evaluation will end evaluation.

For Trials 1-3: Using the assess-a-hand, approach the food bowl containing the mixture of wet and dry food slowly enough to allow the requisite 3 seconds to elapse. Remove the bowl before ending the trial.

<table>
<thead>
<tr>
<th>Trial #1</th>
<th>Approach from Left</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Guarding Seen</td>
<td>Resistance to head push</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial #2</th>
<th>Approach from Center</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Resistance to head push</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial #3</th>
<th>Approach from Right</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Guarding Seen</td>
<td>Resistance to head push</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Trial #4</th>
<th>3s second body stroke</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Guarding Seen</td>
<td>Resistance to head push</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Trial #5</th>
<th>push head from food, center</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Guarding Seen</td>
<td>Resistance to head push</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial #6</th>
<th>push head from food, right</th>
<th>Body Blocking</th>
<th>Accelerated Eating</th>
<th>De-celerated Eating</th>
<th>Cessation of Eating</th>
<th>Muzzle Punch to Bowl</th>
<th>Freeze</th>
<th>Growl</th>
<th>Snarl</th>
<th>Snap</th>
<th>Muzzle Punch to Assess-a-Hand</th>
<th>Bite</th>
<th>Multiple Bite/Shake (Circle)</th>
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<tr>
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<td>No Guarding Seen</td>
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</table>
# HANDLING

*(To be completed on tie-down and with Kevlar – any Snap, Lunge or Bite to the handler or Assess-a-hand® during the test will terminate the test)*

Circle all that apply:

<table>
<thead>
<tr>
<th></th>
<th>Stand</th>
<th>Sit</th>
<th>Lays down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rolls over</td>
<td>Tail wag</td>
<td>Avoid</td>
</tr>
<tr>
<td></td>
<td>Pulls away</td>
<td>Licks handler</td>
<td>Inhibited mouthing</td>
</tr>
<tr>
<td></td>
<td>Lip lick</td>
<td>Pant</td>
<td>Stiffen</td>
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<tr>
<td></td>
<td>Freeze</td>
<td>Orients to handler</td>
<td>Whirl</td>
</tr>
<tr>
<td></td>
<td>Tail tucked</td>
<td>Looks away</td>
<td>Whine</td>
</tr>
<tr>
<td></td>
<td>Growl</td>
<td>Bark</td>
<td>Snarl</td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Snap</th>
<th>Lunge</th>
<th>Bite</th>
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**After test, dog solicits more handling within 5 seconds:**  
*Y / N*

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<tr>
<th></th>
<th>Stand</th>
<th>Sit</th>
<th>Lays down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tail Grasp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rolls over</td>
<td>Tail wag</td>
<td>Avoid</td>
</tr>
<tr>
<td></td>
<td>Pulls away</td>
<td>Licks handler</td>
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<td>Bark</td>
<td>Snarl</td>
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<table>
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<th>Snap</th>
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<th>Bite</th>
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</thead>
<tbody>
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</table>

**After test, dog solicits more handling within 5 seconds:**  
*Y / N*

<table>
<thead>
<tr>
<th></th>
<th>Stand</th>
<th>Sit</th>
<th>Lays down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four Paws</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rolls over</td>
<td>Tail wag</td>
<td>Avoid</td>
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<tr>
<td></td>
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<td>Freeze</td>
<td>Orients to handler</td>
<td>Whirl</td>
</tr>
<tr>
<td></td>
<td>Tail tucked</td>
<td>Looks away</td>
<td>Whine</td>
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<td>Bark</td>
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<thead>
<tr>
<th></th>
<th>Snap</th>
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<th>Bite</th>
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**After test, dog solicits more handling within 5 seconds:**  
*Y / N*

<table>
<thead>
<tr>
<th></th>
<th>Stand</th>
<th>Sit</th>
<th>Lays down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ears</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Rolls over</td>
<td>Tail wag</td>
<td>Avoid</td>
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</tr>
<tr>
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*Y / N*

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<th></th>
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<tbody>
<tr>
<td>Teeth Check</td>
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<table>
<thead>
<tr>
<th><strong>Restraining Hug</strong></th>
<th><strong>Skin Grasp</strong></th>
<th><strong>Collar Grab</strong></th>
<th><strong>Command Test</strong></th>
<th><strong>Stare Test</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pet dog from top of head to tail (3 times)</td>
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</tr>
<tr>
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<td><strong>Lays down</strong></td>
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**Stare Test**

| **Stand** | **Sit** | **Lays down** | **Snap** | **Lunge** | **Bite** |
| **Rolls over** | **Tail wag** | **Avoids** | **Avoids** | **Avoids** | **Avoids** |
| **Pulls away** | **Licks handler** | **Inhibited mouthing** | **Inhibited mouthing** | **Inhibited mouthing** | **Inhibited mouthing** |
| **Lip lick** | **Pant** | **Stiffen** | **Stiffens** | **Stiffens** | **Stiffens** |
| **Freeze** | **Orients to handler** | **Whirl** | **Whirl** | **Whirl** | **Whirl** |
| **Tail tucked** | **Looks away** | **Whine** | **Whines** | **Whines** | **Whines** |
| **Growl** | **Bark** | **Snarl** | **Snarl** | **Snarl** | **Snarl** |
| **After test, dog solicits more handling within 5 seconds:** | | | | |
| **Y / N** | | | | |