

When Fido Sees Red: Aggressive Behaviour in the Domestic Dog

Georgina Beach

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Introduction

Whilst canine enthusiasts commonly accept even the most pampered pooch can and may bite, it is not generally expected your loving FiFi or Fido may put you, your child or your neighbour in hospital. Regrettably, however, it does happen.

In the United States, an estimated 0.5-4.5 million people are bitten by dogs each year. Between 1992-1994, around 333,687 Americans attended emergency departments annually as a result of dog bites; and 316,200 in 2008. Of these, 9,500 people were admitted to hospital (Holmquist & Elixhauser, 2010; Weiss et al., 1998). Each year, at least 15 American dog attacks prove fatal: 70-80% are children aged under 10 years (Ozanne-Smith et al., 2001; Sacks et al., 1996).

In Britain, 400,000-500,000 people are bitten annually, with 250,000 attending emergency departments and ~1,500 admitted to hospital: 2-3 attacks are fatal (Morgan & Palmer, 2007).

In Australia, collation of dog bite statistics is difficult due to variations in the manner data is collected in each State. Many dog bite injuries are dealt with by GPs and thus, may not be recorded beyond individual patient notes (Akerman, 2011; Collier, 2006). Since 1979, Monash University research fellow Linda Watson has accounted for 33 dog-related fatalities (Watson, 2011). In 1995-1996, approximately 1,400 people were admitted to hospitals due to dog bites. Data from the same period puts the Australian fatality rate at 0.004 people per 100,000 head of population, considerably lower than the US rate of 0.05-0.07/100,000, although rates of dog ownership in both countries are similar: being 42% and 37% of households respectively (Ozanne-Smith et al., 2001).

Victorian hospital records from 2005-2007 show an annual average of 1,628 emergency department presentations, 482 hospital admissions and 3 deaths as a result of dog bites. Children under 14 years represented 26% of total cases, and 35% of hospital admissions (Cassell & Ashby, 2009). From 2004-2005, New South Wales local Councils reported 873 dog bites, although the severity was not described (NSW Department of Local Government, 2007).

This paper reviews current research on the ethology, etiology and epidemiology of aggressive behaviour in domestic dogs. By defining canine aggression and its associated physiological responses, and describing some of the more common contexts in which it occurs, a picture of its probable evolutionary purpose becomes apparent. Understanding the instinctive drivers behind aggression can aid us to interpret, predict and thus, prevent this behaviour from causing harm.

Defining Aggression

Most aggressive behaviour is characterised by an intense, overtly expressed emotional response directed at an object of frustration, pain, threat or competition (Kottferova et al., 2008). The exception to this is predatory aggression, which is a comparatively muted and often premeditated response to an object perceived to be prey (Lindsay, 2000). In both cases, the object in question

may be live or inanimate, harmful or harmless, edible or inedible, real or imagined: at the time, it is only the dog's perception of it which counts.

Behaviourist James O'Heare (2007) defines aggression as 'attacks, attempted attacks or threats of attack by one individual directed at another individual', and cites similar definitions from other researchers:

- 'all behaviour patterns which serve to intimidate or damage another organism' (McFarland, 1981)
- '[actions which] cause or threaten to cause injury to another individual' (Leshner, 1978)
- 'any behaviour that frightens or makes you feel uncomfortable when displayed' (Parsons, 2005)
- 'an appropriate or inappropriate threat or challenge that is ultimately resolved by combat or deference' (Overall, 1997)

These definitions focus either implicitly or explicitly upon the imminent likelihood of injury inherent in a display of aggression. This is unsurprising: as when faced with aggression, people tend to be preoccupied with that risk, either to themselves or others. In other words, it is our nature to focus on the outcome (the symptoms), rather than the cause.

However, in order to understand and thereby hopefully aid in reducing the occurrence of aggression, it is essential to look past our own fears, and examine the etiology of the behaviour. To this end, Wilson (1975) defines aggression as a 'physical act or threat of action by one individual that reduces the freedom or genetic fitness of another', thereby hinting at the drivers *behind* aggression. Likewise, renowned behaviourist and trainer Stephen Lindsay (2001), writes 'functionally speaking, aggressive behaviour...can be viewed as an adaptive effort to establish control over some vital resource or situation that cannot be effectively controlled through any other means'; whilst Miklosi (2007) states 'the main function of aggression is to divide important but limited resource among group members'. These definitions are far more useful, assisting us to view the scenario from aggressor's (dog's) perspective. This perspective provides valuable insight into the potential evolutionary purpose of aggressive behaviour in dogs; and is equally applicable to two poodles competing for their owner's attention as it is to two wolves competing over a carcass.

Aggression can be classified as either intra- or interspecific. Intraspecific means occurring between two members of the same species; whilst interspecific means occurring between members of two different species. In dogs, intraspecific aggression is a distance-increasing signal. It serves a clear biological function, such as social/hierarchical organisation, protection of resources, encouragement of dispersal or facilitation of mate choice. Intraspecific aggression to familiar conspecifics is usually inhibited and highly ritualised (all show, no action), thereby communicating intent whilst reducing the risk of injury. Depending upon the scenario, aggression towards unfamiliar conspecifics may be less ritualised and comparatively uninhibited, and hence, has greater potential to result in injury or death (Aloff, 2002; Fogle, 1990; Fox, 1969; Lindsay, 2001).

Interspecific aggression generally reflects offensive or defensive intent, driven by anger or fear, respectively; but, it can involve a combination of the two (Lindsay, 2001). The level of ritualisation varies: it is absent in predatory offensive aggression; but may be high in fear-based defensive aggression, whereby an anxious aggressor may prefer to bluff his way out of an undesirable situation, rather than be forced to follow through with a threatened attack.

Types of Aggression

Aggression can be divided into several categories, based upon the social status of the aggressor; the environmental situation; the message the aggressor wishes to convey; and the motivation behind it

(Kottferova et al., 2008; Lockwood, 1995). Of course, different researchers categorise aggression differently, due to their respective perspectives as biologists, ecologists, ethologists, canine behaviourists or professional dog trainers; but most agree on the following broad groupings...

1) Defensive Aggression

As a behaviourist, obedience instructor and veterinary nurse, I have found defensive aggression to be the most common form encountered across all breeds of dog. It also appears to be the type most frequently misinterpreted by onlookers.

Often referred to as 'fear aggression', it stems from an instinctive fear of anything perceived to be potentially painful or predatory. Dogs who were inadequately socialised as puppies with other dogs, people, animals and noisy appliances or machinery may exhibit defensive aggression when encountering these things for the first time later in life. Furthermore, dogs who have suffered a bad experience - for example, at the hands of a veterinarian, a boisterous toddler or another dog - may behave selectively aggressively towards similar stimuli in future, in the hope of frightening it off, and thereby, protecting themselves from it. Generally, dogs would much prefer to flee such situations, and usually only resort to defensive aggression if escape is prevented (Aloff, 2002; Case, 2005; Fogle, 1990; Kottferova et al., 2008; Lindsay, 2001).

2) Dominance Aggression

Dogs displaying any form of aggressive behaviour are frequently labelled 'dominant', mistakenly, by the inexperienced and/or ill-informed. Such misinterpretation of behaviour poses risks to both the dog and people involved, as inappropriate handling of the situation is likely to follow (Aloff, 2002; Lindell, 2010). Hence, experienced behaviourists are often hesitant to apply the word 'dominant', even to cases where it is justified, to avoid evoking this stereotype. Trainer, Brenda Aloff (2002) prefers to call this category 'control-conflict aggression', and emphasises the rarity with which a dog displays aggression solely with the intent of dominating another individual, be they dog or human. She describes those fitting this classification as being 'obsessive about rank order'. In other words, it's more of a human concept than a doggy one - most of the time.

True dominance aggression is highly ritualised, and is driven by competition and control. It may be triggered by a perceived challenge to that dog's social status. Its motivation is the desire to generate social distance and enforce a social hierarchy within the setting of a familial group (Case, 2005; Fogle, 1990; Kottferova et al., 2008; Lindsay, 2001).

Dominance aggression is generally most intense between two dogs of the same sex, being a function of the separate sex-based social hierarchies which exist in a canid pack. Although in the case of intermale aggression, some prefer to categorise this as territorial aggression (section 3), due to its links with urine marking of territorial boundaries (Lindsay, 2001). However, in saying this, it must be remembered, contrary to popular opinion, most dogs do not think of themselves and their families as being a pack in the sense applied to wolves and other wild animals.

3) Protective Aggression

Protective aggression is epitomised by territorial and maternal aggression, and has a logical ecological purpose. Instinctive self-preservation drives wild canids to protect their offspring and other members of their pack; and, in the case of territorial aggression, to protect critical local resources required for their survival (Kottferova et al., 2008). In domestic dogs, this behaviour can

be described as a 'repel all boarders' attitude, and includes guarding of the home and/or yard, family members and even vehicles or family members' personal possessions (e.g. owner's shoes). Most commonly triggered by the approach of an unfamiliar human, some dogs may generalise this behaviour to include approaching vehicles, dogs and other animals (Aloff, 2002; Case, 2005).

4) Possessive Aggression

Easily confused with protective behaviour, possessive aggression is best described as being more akin to spoilt sibling rivalry when compared to the more ecologically defensible protective aggression (Fogle, 1990). Whilst its display over bones and bowls of food may be regarded as natural and hence, acceptable, when found hand-in-hand with dominance aggression, it can become unmanageable and from a human standpoint, unreasonable.

Extreme possessive behaviour manifests as intense aggressive control over toys; collars/leads; favourite sleeping places; access rights to certain rooms; priority of passage through gates or doorways; or even competition over attention from the dog's owner. Possessive conflicts may arise between dogs in a multi-dog household, or between a dog and family members or visitors (Case, 2005; Fogle, 1990). This can even include in the classic comedic example of a woman's dog blocking the advances of a boyfriend!

5) Learned Aggression

Dogs are taught to behave aggressively under controlled circumstances in the police, military and Schutzhund sporting community, whereby aggressive behaviour is aroused on command or upon recognition of threatening circumstances. Aggression is also fostered by unlawful individuals who breed and condition dogs to fight competitively (Aloff, 2002; Fogle, 1992).

Alternatively, dogs may learn aggression is effective in achieving a desired outcome: for example, many dogs discover an aggressive display successfully prevents someone from performing a task the dog dislikes, such as brushing or nail clipping. Conversely, in a case I observed, a Chihuahua learnt barking and growling made his owner give him a treat, and hence, he proceeded to make regular use of this effective ploy. Behaviourist Patricia McConnell (2002) has observed similar cases of clients' dogs ordering their owners about by using aggression.

6) Idiopathic aggression

Idiopathic aggression is a genetic disorder arising in certain breeds, such as Cocker Spaniels, English Springer Spaniels, Bernese Mountain Dogs and in the past, Pyrenean Mountain Dogs. It is also known as Jekyll-Hyde or Rage Syndrome, whereby, at random intervals, a usually contented, affectionate dog suddenly explodes into an aggressive fury with literally no trigger. Clinical examinations have yet to isolate the part of the dog's brain involved (Aloff, 2002; Fogle, 1990).

7) Redirected Aggression

When a dog is prevented from reaching the target of his aggression, he may vent his frustrated behaviour on the nearest being. For example, when physically restrained from attacking an approaching dog, an aggressive dog may turn and bite his handler instead. Similarly, in a multi-dog household, a territorially aggressive dog may bite the dog beside him when he is unable to reach an intruder on the other side of the gate (Aloff, 2002; Case, 2005; Lindsay, 2001).

8) Predatory Aggression

This category has been placed last, as some researchers reject the description of predatory behaviour as 'aggressive', as predation is not driven by emotion. Furthermore, predatory aggression is controlled by a separate part of the brain from those other forms of aggression, as discussed further below (Aloff, 2002; Lindsay, 2000, 2001).

Predatory behaviour is characterised by a calm, inwardly and outwardly quiet, genetically premeditated and highly skilled attack sequence. Driven by a predator's primal instinct to obtain food, the evolutionary role of this behaviour is clear. Taking on the appearance of the classic hunt televised in nature documentaries, the process may include stalking; chasing; a 'grab-bite' to catch the prey; and a 'kill-bite' to despatch it; followed by dissection and ingestion. True predatory aggression, culminating in a kill or attempted-kill, is not often displayed by domestic dogs, but can appear in any breed. Indeed, the intensely focused herding techniques displayed by working sheep and cattle dogs is in fact a highly modified version of naturally predatory behaviour, isolated and refined by selective breeding (Aloff, 2002; Coppinger & Coppinger, 2001; Fogle, 1990).

Physiology of Aggression

Physiologically, aggressive behaviour falls into two categories; termed 'quiet attack' and 'affective aggression'. A quiet attack equals predatory aggression, which is characterised by the silent, careful nature of the quintessential predator's approach towards its prey whilst affective aggression represents the remaining categories of emotionally driven aggressive behaviour (Lindsay, 2000).

Neurological studies have shown these two categories of aggression are linked to separate areas of the brain, with quiet attacks evoked by stimulation of the lateral hypothalamus, and affective aggression aroused via the ventromedial hypothalamus. These studies showed that delivering a quiet attack is a pleasurable experience (Lindsay, 2000). Perhaps this sense of pleasure is an evolutionary adaptation to drive a predatory canid to continue hunting following a failure.

Conversely, the highly emotive response characteristic of affective aggression appears to be strongly aversive, with electrical stimulation of that part of the brain triggering deliberate avoidance (Lindsay, 2000). This would imply that, like most of us, dogs would prefer not to experience the unpleasant feelings inherent in becoming aggressively disposed.

Outwardly, dogs may exhibit numerous postural and behavioural changes at varying levels of intensity depending upon the type of aggression, social and environmental context and the level of ritualisation involved. Postural responses may include piloerection (hackles raised); bared teeth; erect ears and forward; stiffened posture and gait; and a stiffened and sometimes slowly wagging tail. Vocal responses may include snarling; growling; barking and/or baying (Feddersen-Peterson, 2007; McConnell, 2002). Displacement activities, such as repeated yawning, sneezing, scratching, shaking or sniffing the ground, may be displayed during the preliminary stages of an encounter (Aloff, 2002). Of course, as implied by its name, the 'quiet attack' of predatory aggression involves few of these behaviours compared to the more overt affective aggression.

Due to the morphological and behavioural modifications undergone by domestic dogs as a result of controlled breeding, dogs have been found to be far less ritualistic in their aggressive displays compared to wolves, jackals and other wild canids. As a result, the frequency and severity of aggressive encounters may be far worse in domestic dogs than amongst their wild relatives (Feddersen-Peterson, 2007; Lockwood, 1995).

Contributing Factors

When cornered or restrained, dogs are generally more prone to aggressive behaviour than if they are free to retreat. Dogs in cars, cages, behind fences/doors/windows, chained or on lead are more likely to attempt to fight all-comers. The seemingly obvious explanation for this is fear induced by an inability to escape, but some scenarios indicate other factors may be at work. Perhaps the presence of the owner at the other end of the lead is arousing protective aggression; or the owner's own feelings of tension under a particular set of circumstances are transmitted to the dog, triggering a fearful and/or protective response. Alternatively, perhaps being within a fence, cage or house inspires territoriality - or, correlates with the close proximity of food, toys and other favoured possessions, evoking possessive aggression (Aloff, 2002; Lindsay, 2001; O'Heare, 2007)

The use of electric shock collars linked with 'invisible' electric fencing is known to heighten aggression, as the approach of a person or other dog causes the subject dog to move to the boundary of their territory, resulting in a shock from the collar, which the dog then blames on the intruder (O'Heare, 2007). In the case of predatory aggression, this behaviour is often elicited by small, swiftly moving objects, children or animals, particularly if such movement is accompanied by high-pitched noises akin to an animal squealing in fright.

Dogs suffering from low levels of the neurotransmitter serotonin have reduced control over emotional impulses, similar to humans suffering from depression. Reduced impulse control tends to result in low reactivity thresholds, and hence, higher rates and intensities of aggressive behaviour (O'Heare, 2007). In intact females, seasonal fluctuation in hormone levels relative to their reproductive cycles can cause changes in levels of aggression, as does pregnancy and/or the presence of offspring or perceived/imagined offspring (Fogle, 1990).

In addition, injured, ill or arthritic dogs tend to have a lowered tolerance for situations or activities which, once, would have failed to faze them; and hence, may be more prone to impatience, irritation and subsequent aggressive behaviour.

Effect of Sex and Reproductive Status

The evidence indicates aggressive behaviour is strongly influenced by the dog's sex, and whether or not it has been surgically desexed. More than half the dogs reported to display aggressive behaviour, either towards humans or other dogs, are reproductively intact males (Beaver, 1983; Roll & Unshelm, 1997; Wright, 1996). According to several studies, spayed females are the next group most likely to behave aggressively (Jones & Gosling, 2005), followed by castrated males, and lastly, intact females (Wright & Nesselrote, 1987).

Following home visits to 245 cases of dogs displaying some form of aggressive behaviour, Borchelt (1983) found 67.4% of these dogs were male, with the majority of these (86%) being reproductively intact males. Conversely, amongst aggressive female dogs, 68% had been spayed, indicating desexed females may be more likely to be aggressive than intact females. This mirrors findings by Wright and Nesselrote (1987), whereby 48% of aggressive dogs were intact males and 28% were spayed females. Castrated males and intact females each comprised 12%.

In direct attacks on people, Beck *et al.* (1975) found 70% were male dogs, whilst in a separate study, Moore (1987, as cited in Lockwood, 1995) found 60% were intact males, 17% castrated males, and 13% females, of which half were spayed.

Heritability of Behaviour

Canine behaviourist Stephan Lindsay (2001) states there is ‘a strong heritable factor affecting the predisposition of dogs to behave aggressively’. Research to date indicates he is correct. The nature-versus-nurture debate has long been a focal point in investigations into the reasons behind behaviour in all of us ... however, in the 1950s-60s, Scott and Fuller (1965) conducted pioneering research into the role of genetics in temperament and behaviour in dogs. Through careful breeding and crossbreeding of four purebred breeds of dog, Scott and Fuller demonstrated that temperament, and the associated predisposition towards certain behavioural responses (such as aggression), is genetically controlled, and thus, heritable over generations (Haupt, 2007; Jazin, 2007; Saetre et al., 2006).

In other words, dogs can be bred to be more likely to behave in certain ways, e.g. to display intense stalking behaviour (such as ‘eye’ in a Border Collie), or intense territorial behaviour (such as instinctive guarding in a Rottweiler). Similarly, dogs can be bred to be more or less aggressive. These predispositions arise through *nature*, and although they may be able to be encouraged or repressed by *nurture*, (i.e. the environment in which the dog is raised), it likely still will prove difficult to train a Collie to guard, or a Rottweiler to herd sheep (Svartberg, 2007).

The Bernese Mountain Dog is a good illustration of the potential to select against an aggressive predisposition: for some time, this breed was prone to aggressive behaviour towards people; however, conscientious breeders have all but eliminated this problem, by selecting for more docile dogs (Van Der Velden et al., 1976).

Saetre *et al.* (2006) studied the heritability of 16 behavioural traits in over 10,000 German Shepherds and Rottweilers in Sweden, finding most, if not all traits can be transmitted between generations, most particularly aggression and a tendency towards shyness or boldness. Similarly, a breeding program combining purebred Border Collies and Newfoundlands found subsequent generations inherited either the Newfoundland’s innate love of water and friendliness towards humans, or the Border Collie’s intense ‘eye’ and herding behaviour (McCaig 1996). Meanwhile, an unrelated program breeding Pointers managed to create two distinct lineages defined by consistent behavioural differences: one wherein all dogs produced were friendly and trainable; and the other wherein all progeny were perpetually nervous and intractable in the extreme.

‘Breedism’

Professor Daniel Freedman wrote ‘a breed of dog is a construct zoologically and genetically equivalent to a race of man’ (1979). Dog breeds are often used as an analogy for human races: as whilst each group appears different on the surface, all are members of one species, and thus, physiologically alike and capable of interbreeding. Yet, if one consults popular guides to dog breeds, each breed is listed with its size; weight; exercise needs; grooming needs; and a description of how easily it can be trained; and how it is likely to relate to its owner, owner’s family and other pets. In a human context, this catalogue-style approach would be classified as racism: akin to claiming all members of a particular race have prominent noses and a tendency towards rudeness. At least, this is the argument put forth by opponents of the generic aggressive stereotypes commonly applied to certain breeds, such as Rottweilers, Dobermanns and Pit Bulls (Bandow, 1996).

However, races of people were not selectively bred as were/are breeds of dog. Whilst many human civilisations endured geographical and subsequent cultural isolation leading to minor genetic and corresponding phenotypic changes; the artificial isolation of dog breeds has been compounded by

culling of individuals who do not conform to current aesthetic, functional or behavioural ideals (Coppinger & Coppinger, 2001; Svartberg, 2006).

Different breeds of dog have arisen due to different sectors of society selecting for (and against) specific physical and/or behavioural traits. Today, breeds can be divided into four groups according to genetic relatedness: the spitz type dogs (including Chow Chow, Akita, Husky, Malamute); the mastiffs and old fighting breeds (including Boxer, Pit Bull, Staffordshire Bull Terrier, English Bull Terrier, English Bull Dog and, interestingly, the Bernese Mountain Dog); the herding breeds and some sighthounds (including Border Collie, Collie, Kelpie, Shetland Sheepdog, Greyhound); and the hunting breeds (gun dogs, retrievers, hounds and terriers). These groupings do not necessarily correspond with the categories employed by Kennel Councils and associated dog shows, which are based primarily on appearance, and to a lesser extent, historical uses for each breed (Houpt, 2007).

In some breeds, selection has prioritised physical characteristics, driven by fashion or function - e.g. the neotenic features of a Pug, or the long limbs of a Greyhound (Pasi & Carrier, 2003) - whilst in others, selection has prioritised behavioural traits, like the herding behaviour of a Border Collie. In some hunting dogs, selection has focused upon a combination of physical and behavioural features, such as high prey drive, strong eyesight and tenacity. Over time, these interbreed differences have become both exaggerated and cemented, hence modern purebred dogs are reliably replicable in size, colour, shape and in many cases, specialised ability (Saetre et al., 2006; Svartberg, 2006).

It is logical to presume the same has occurred with behaviour. Following on from Scott and Fuller (1965) and Saetre *et al.*'s (2006) convincing work demonstrating the transmission of behavioural traits, or personality, across generations, it is becoming clear that the closely controlled breeding employed in the world of purebred dogs has consolidated particular behavioural traits in certain breeds. In other words, breedism just might be true.

Houpt (2007) reviews a number of behavioural studies by different researchers utilising varied methods of research, ranging from laboratory-based temperament test-batteries; breeding experiments and surveys of professionals in dog-related fields including veterinarians, behaviourists and professional trainers. Collectively, these studies offer significant evidence that different breeds exhibit consistent differences in behavioural tendencies, particularly in terms of emotionality/reactivity, aggressiveness, activity and predatory behaviour. Further surveys conducted by Bradshaw and Goodwin (1998) and Hart (1995) ranked breeds according to levels of reactivity, aggressiveness and ease of house-training, and achieved comparable results.

Examining the question of breed-specific temperament in reverse, Cattell *et al.* (1973) assessed 101 dogs belonging to five breeds to determine whether the breed of each dog could be correctly identified by its behaviour alone. The results were positive, with most members of three out of the five breeds clustering neatly into their breed-based groups. (One of the breeds which did not cluster well was a comparatively 'new' breed, hence, was thought to have been a bad choice to use).

Pleiotropy: Aggression by Accident

Dog breeders focused on producing and refining a particular physical or behavioural trait have disregarded the potential effects of pleiotropy: that is, the concept that each gene produces multiple effects - such as lop ears *and* curly tails - which, otherwise, may have been presumed to be unrelated (Scott & Fuller, 1965). Thus, selecting for a currently fashionable/functional trait may inadvertently select for other, potentially undesirable physical or behavioural traits.

Dmitry Belyaev's famous 40-year experiment breeding Silver Foxes in Russia provides a perfect example of pleiotropy in action. By selecting solely for tameness, Belyaev inadvertently produced foxes with lop ears, curved tails and patchwork coat colours: i.e. clearly, the genes responsible for tameness were also partially or wholly responsible for ear/tail shape and coat colour (Trut, 1999). Considering this in reverse, it is easy to understand how a dog breeder selecting for a specific appearance may inadvertently produce a dog with an equally specific temperament (Saetre, et al., 2006). Thus, it is not surprising breed-specific differences in temperament exist (Haupt, 2007).

In their study of German Shepherds and Rottweilers, Saetre *et al.* (2006) found several of the 16 behavioural traits targeted to be genetically interrelated. This corresponds with the concept of pleiotropy, and potentially explains why breeders selecting for a certain behaviour may find themselves producing dogs equally likely to display other, unexpected but genetically related behaviours. Interestingly, however, this study found aggression to be one of the few traits which seemed to be inherited independently of any of the other 15 behavioural traits examined. This does not mean aggression could not be genetically related to other behavioural or physical traits; simply that this question requires further investigation.

The English Springer Spaniel, Cocker Spaniel, Lhasa Apso and Toy Poodle were not intended to be aggressive dogs, however dogs of each breed are prone to displaying aggressive behaviour towards people (including their owners) and other dogs (Borchelt, 1983; Haupt, 2007). In such cases, this could be presumed to be as a result of pleiotropy, whereby breeders' selection for certain desirable characteristics has led inadvertently to selection for high reactivity and aggression. Amongst English Springer Spaniels, it is interesting to note aggression is more common in dogs from show breeding lines, rather than those from working gun dog lines (Duffy et al., 2008).

Aggression by Design

Of course, some sectors of society have *intentionally* selected for an aggressive disposition in particular breeds. The obvious example which springs to mind is the bull-baiting and pit-fighting breeds, which were bred specifically to provide sport for humans to watch and gamble upon. The British Bulldog was bred for bull-baiting, where the dog was required to kill a bull tied to a post. The English and American Staffordshire Terriers, American Bull Dog, American Pit-Bull and English Bull Terrier, to name a few, were bred to fight other dogs in 'pit-fights'. However, the English Bull Terrier proved ineffective and was soon bred purely for fashion, hence the selection for high-white colouration (Morris, 2008).

Despite these bloodthirsty sports having been banned in many countries, these breeds of dog still retain a higher-than-average tendency towards aggression: they have a low reactivity threshold, and a high pain threshold, which makes them difficult to stop once they begin (Lockwood, 1995).

Meanwhile, several breeds have been bred to display aggression towards people (Haupt, 2007), in order to serve as guard, police, prison and military dogs, and to compete in the sport of Schutzhund. Some of the most common breeds in this category are Dobermanns, Rottweilers, German Shepherds and Belgian Malinois. Although breeding programs producing such dogs generally focus on an equally high level of trainability and obedience, these dogs are still predisposed towards aggression - they are always 'on guard'.

Aggressive versus “Dangerous”

Aggressive-in-theory may not equate to dangerous-in-reality. Physical capabilities and inherited behavioural sequences may determine the damage caused. Some small breeds like Dachshunds, Chihuahuas and Jack Russell Terriers are notoriously aggressive (Duffy et al., 2008), but their diminutive stature makes them unlikely to be labelled dangerous. (Although Sacks et al. (2000) reported two fatal attacks by Dachshunds). Different breeds may possess innate differences in their manner of displaying aggression, thereby altering the dangerousness of that behaviour (Collier, 2006): for example, a herding breed selected for bite inhibition may posture and growl before biting, making injury less likely; whereas a former fighting breed, selected to show little warning of aggressive intent, may bite before the victim has time to react (Overall & Love, 2001).

Thus, in order to determine relative dangerousness, one must no longer consider rates of aggressive displays towards people, but, putting it bluntly, rates of damage. Thus, analysis of statistics for dog-related hospital admissions and/or fatalities seems the best method of determining whether breed-associated patterns exist.

Three studies, in Austria (Schalamon et al., 2006) Belgium (Kahn et al., 2003) and the USA (Brogan et al., 1995), examined hospital records for children under 16 years who were attacked by dogs. All three found German Shepherds responsible for the most attacks: 34% in Austria; 28% in Belgium; and 22% (plus a further 11% German Shepherd crosses) in the USA. In Belgium and the USA the next largest figures were for Rottweilers (11% and 16%), followed by Labradors in Belgium (9%) and Pit Bulls in the USA (9%). Conversely, Austria had a large number of attacks by crossbreeds (13%) after which percentages were spread evenly across a dozen other breeds.

Two studies examining fatal dog attacks in the USA suggest a change in the most dangerous breeds over time, perhaps due to corresponding changes in popularity. Of 73 deaths between 1966-1980, Pickney and Kennedy (1982) found the top three breeds responsible were German Shepherds (21.9%), Huskies (12.3%) and Saint Bernards (11%). However, of over 200 deaths between 1979-1998, Sacks *et al.* (2000) found Pit Bulls and their crosses responsible for 31.9%, Rottweilers and their crosses for 18.5% and German Shepherds and their crosses only 11.3%.

Statistics on Australian attacks identifying the breeds involved are rare (Ozanne-Smith et al., 2001). In New South Wales, out of 873 non-fatal attacks reported to local councils in 2004-2005, German Shepherds were responsible for 7.2%, Australian Cattle Dogs for 6.8%, Rottweilers 6.6%, Staffordshire Bull Terriers 4.7% and Pit Bulls 3.8% (NSW Department of Local Government 2007).

Examining records of 356 attack victims treated at a metropolitan hospital in Adelaide between 1990-1993, Thompson (1997) found the top five dogs responsible for attacks were German Shepherds (25.3%), Bull Terriers (21%), Cattle Dogs (21%), Dobermanns (18%) and Rottweilers (14%). The Victorian Bureau of Animal Welfare analysed dog attacks in public places between 1997-1999. Of 413 injuries reported, only 20 required two or more sutures. German Shepherds were responsible for 30.8%, Cattle Dogs for 21.8%, Rottweilers 17.2%, Kelpies 9.7% and Staffordshire Bull Terriers 9.7% (Van de Kuyt, 1999 as cited in Collier, 2006).

Interpretation of these percentages is not straightforward. Firstly, the method of identification of the breed accused is not specified in many of these studies. Unfortunately, few people have adequate dog breed identification skills, and are certainly unable to deduce the composition of crossbreeds accurately. Frequently, dog owners themselves are unable to identify their own dog's breed (Collier, 2006; Ozanne-Smith et al., 2001; Sacks et al., 2000). Often newspaper articles are

the only data source, which are notorious for erroneous information, particularly in the case of breed identification (Collier, 2006; Watson, 2003).

Additionally, the percentage of attacks for which a particular breed is responsible may not be a factor of the relative aggressiveness/dangerousness of that breed alone: the popularity of that breed - i.e. the relative frequency with which one breed is likely to be encountered in the community compared to others - must be considered. For example, in Belgium, where 9% of attacks are committed by Labradors, this is more likely to be due to the immense popularity of this breed, rather than above-average aggression in those dogs, which are ordinarily docile (Thompson, 1997).

Last but not least, some consideration must be given to the demographics of the owners of dogs responsible for severe attacks. Generally speaking, aggressively inclined people are often attracted to certain breeds, and are known to encourage aggression in their dogs. Thus, is it possible that even if society was to remove an apparently dangerous breed from the equation, the owners formerly drawn to that breed would simply move on to another breed, and encourage similar aggression in those dogs instead (Overall & Love, 2001; Sacks et al., 2000; Thompson, 1997).

Breed-Specific Legislation

For over 70 years, Governments around the world have introduced breed-specific legislation (BSL) to restrict the proliferation of selected breeds of dog by banning their import and breeding and either sterilising or euthanasing existing individuals. BSL usually focuses upon American Pit Bull Terriers and other fighting breeds including the Dogo Argentino, Mastino Napoletano, Japanese Tosa and Fila Brasileiro, but may also impact upon more common breeds such as American and English Staffordshire Bull Terriers, English Bull Terriers, Rottweilers, Dobermanns and less frequently, German Shepherds, Rhodesian Ridgebacks and other large breeds (Watson, 2003). It is interesting to note how infrequently German Shepherds are targeted by BSL, considering they are responsible for the largest percentage of attacks (as discussed above). To date, only limited research has been conducted examining the efficacy of BSL (Collier, 2006).

The United Kingdom introduced BSL in 1991 in the form of the *Dangerous Dogs Act*. Prior to its enactment, Klaassen *et al.* (1996) examined hospital emergency department admissions due to dog attacks over a three month period; and repeated this process over a second three month period two years after the Act came into force. Both before and after the Act, 99 people were admitted to the same hospital with dog bite wounds. Before the Act, 24.2% of bites were caused by German Shepherds, 18.2% by crossbreeds, and 6.1% by Pit Bulls, Rottweilers and Dobermanns combined. Three years after the Act, 30.6% of bites were caused by crossbreeds, 17.4% by German Shepherds, and 11.2% by Pit Bulls, Rottweilers and Dobermanns combined (Klaassen, et al., 1996). Admissions to British hospitals as a result of dog attacks have since increased 25% (Collier, 2006). At an estimated cost of US\$14 million, the UK *Dangerous Dog Act 1991* is described by many as a failure (AVA 2012; Lodge & Hood, 2002). Both the British Veterinary Association and the British Small Animal Veterinary Association are opposed to BSL (BVA & BSVA, 2012).

Fifteen years following the introduction of BSL, the Government of the Netherlands commissioned an independent study to examine its efficacy. This research revealed BSL had failed to reduce the number of dog attacks in the Netherlands, and that its premise of classifying breeds based on aggressive potential or perceived attack record was fundamentally flawed. Hence, the Government repealed the legislation in June 2008 (Anon, 2008; Cornelissen & Hopster, 2010). Similarly, the German state of Lower Saxony introduced BSL in 2000, only to repeal it in September 2002 when a

study using breed temperament tests found no correlation between aggressive behaviour and the breeds affected by the legislation (Schalke et al., 2008).

Italy introduced a dangerous dog blacklist in September 2003, banning 92 breeds, from Rottweilers to Corgis (AVA, 2012). Over time, this list was reduced to 17 breeds, until in 2009, the Government removed the law completely, stating it was not possible to determine aggressiveness based on breed; although they produced no studies to backup this view. New laws focusing on responsible ownership replaced the blacklist (Italian Ministry of Health, 2009). In Ohio, USA, the Cincinnati municipality repealed its breed-specific ordinances, labeling them ineffective, whilst nine States have legislated to prevent local governments from introducing BSL (Watson, 2003).

Conversely, in Canada and Spain, the number of dog bite victims admitted to hospital declined following the introduction of BSL. In Canada, several jurisdictions within the Province of Manitoba began introducing BSL from 1990, and Raghaven *et al.* (2012) analysed temporal differences in hospitalisations in these regions between 1984-2006, finding a reduction over time. However, the authors noted this study may have been confounded by the extended period of time incorporated, and the potential for other social changes to have affected dog attack rates over that time, coupled with wide variations in the type of breed restrictions imposed (e.g. higher registration fees versus outright bans) and their level of enforcement in each jurisdiction. Spain introduced BSL in 1999, and a study of hospitals in Catalonia from 1997-2008 showed a drop in dog bite related cases of 38% (Villallbi et al., 2010). However, the Spanish legislation simultaneously implemented new measures aimed at fostering more responsible dog ownership, hence, the reduction in attacks may not be solely attributable to breed bans (AVA, 2012).

Australia introduced legislation in 1991 to ban the importation of the American Pit Bull, Dogo Argentino, Fila Brasileiro, Presa Canario and Japanese Tosa - although the Pit Bull is the only one of these known to exist in the country in significant numbers. Each of the States followed suit between 2004-2009, banning the breeding of these dogs. In 2011, following the death of a Victorian child due to an attack by a pit bull cross mastiff, Victoria strengthened these laws, requiring euthanasia of any unregistered dog which vaguely resembled a restricted breed, and did not possess pedigree papers to prove otherwise. Owners of restricted breed dogs were given until 30 September 2011 to register their dogs, or have them seized and destroyed (Victorian DPI, 2012).

To date, no studies have determined whether or not Australian BSL has reduced the incidence of dog attacks, or the composition of the breeds responsible; however, researchers are skeptical as to its efficacy (Collier, 2006; Watson, 2003). The Australian Veterinary Association (AVA), Royal Society for the Prevention of Cruelty to Animals (RSPCA), Animal Welfare League Australia and the Australian National Kennel Council are all vocal opponents of breed-specific legislation.

Conclusion

All dogs bite: but aggressive behaviour in dogs is a far more complex ethological issue than that familiar idiom implies. As intelligent predators, with social structures as intricate as our own (Helton, 2009), our ability to interpret the causative factors and communicative intent of their agonistic interactions with us and each other requires years of study and observation. Even then, the momentary nature of such interactions and the wealth of detail rapidly incorporated therein can still prove too daunting to decode in on-the-spot situations.

The chances of a dog being predisposed towards behaving aggressively is greatly influenced by the breed composition, sex and reproductive status of that dog. Whilst there is always room for

individual differences, particularly as a result of environmental factors, the average Dobermann, for example, is more likely to behave aggressively than the average Border Collie (Hart, 1995), and an intact male is more likely to behave more aggressively than any other category (Wright, 1996). Such information can help us, as dog trainers, to assess the relative risk inherent in individual dogs presented for rehabilitative training, based upon these factors.

Whilst research into the heritability of behavioural traits in dogs remains in its early stages (Svartberg, 2006), the evidence to date regarding the heritability of aggression, shyness/boldness and reactivity is compelling, and the concept, fascinating. What remains to be clarified is the intriguing question of the relative influence of pleiotropy.

Considering even Dachshunds and Yorkshire Terriers have been known to kill, the concept of breed-specific legislation appears to be fatally flawed. Although at any given time, one or a small number of breeds may be responsible for a higher percentage of severe attacks, their behaviour seems predominantly symptomatic of ownership demographic and environmental circumstances which foster aggressive incidents. Thus, even if these breeds are filtered out of society, the true causal factors will remain and merely be redirected to the 'next best' breed. In other words, irresponsible owners with a penchant for intimidating pets will still exist, and will simply find another breed to fulfill their misguided desires (Collier, 2006; Sacks et al., 2000). If even apparently innocuous small breeds can be lethal, then it would be impossible for legislation to remove enough breeds of dog to eliminate this risk.

As Lindsay (2001) so succinctly puts it, 'the goal of aggression is control'. If we, as dog owners, learn to understand and manage our dogs' lives in such a way that they do not feel the need to take independent control, we will greatly reduce the chances any of us coming to serious harm.

References

- Ackerman, P. (2011, September 8). Dog fight brews over tough laws. *The Australian*. Retrieved from: <http://www.theaustralian.com.au/news/features/dog-fight-brews-over-tough-laws/>
- Aloff, B. (2002). *Aggression in Dogs: Practical Management, Prevention & Behaviour Modification*. Wenatchee, USA: Dogwise Publishing.
- Anon. (2008). *Dutch Agriculture Minister scraps pit bull ban*. Retrieved from http://www.expatica.com/nl/news/local_news/Dutch-Agriculture-Minister-scraps-pit-bull-ban.html
- Australian Veterinary Association. (2012). *Dangerous Dogs: A Sensible Solution*. Retrieved from http://www.ava.com.au/sites/default/files/AVA_website/pdfs/Dangerous%20dogs%20-%20a%20sensible%20solution%20FINAL.pdf
- AVA - see Australian Veterinary Association
- Bandow, J.H. (1996). Will breed-specific legislation reduce dog bites? *Canadian Veterinary Journal*, 37, pp. 478-481.
- Beaver, B.V. (1983). Clinical Classification of Canine Aggression. *Applied Animal Ethology*, 10, pp.35-43.
- Beck, A.M., Loring, H. & Lockwood, R. (1975). The Ecology of Dog Bite Injury in St Louis, Missouri. *Public Health Reports*, 90(3), pp.262-267.
- Borchelt, P.L. (1983). Aggressive behavior of dogs kept as companion animals: classification and influence of sex, reproductive status and breed. *Applied Animal Ethology*, 10, pp.45-61.
- Bradshaw, J.W.S. & Goodwin, D. (1998). Determination of behavioural traits of pure-bred dogs using factor analysis and cluster analysis; a comparison of studies in the USA and UK. *Research in Veterinary Science*, 66, pp.73-76.

- British Veterinary Association & British Small Animal Veterinary Association. (2012). *BVA/BSVA joint response to the consultation on dangerous dogs*. Retrieved from http://www.bva.co.uk/public/documents/BVA-BSAVA_response_to_EFRA_Com_Inquiry_final.pdf
- Brogan, T.V., Bratton, S.L., Dowd, M.D. & Hegenbarth, M.A. (1995). Severe Dog Bites in Children. *Pediatrics*, 96(5), pp.947-950.
- BVA & BSVA - see British Veterinary Association & British Small Animal Veterinary Association
- Case, L.P. (2005). *The Dog: It's Behaviour, Nutrition and Health* (2nd ed.). Iowa, USA: Blackwell Publishing.
- Cassell, E. & Ashby, K. (2009). Unintentional dog bite injury in Victoria: 2005-7. *Hazard*, 69, pp.1-23.
- Cattell, R.B., Bolz, L. & Korth, B. (1973) Behavioral Types in Purebred Dogs Objectively Determine by Taxonome. *Behavior Genetics*, 3, pp.205-216.
- Chapman, S., Cornwall, J., Righetti, J. & Sung, L. (2000). Preventing Dog Bites in Children: Randomised controlled trial of an educational intervention. *British Medical Journal*, 320(7248), pp.1512-1513.
- Coile, D.C. (2005) *Encyclopaedia of Dog Breeds*. New York, USA: Barrons Educational Books.
- Collier, S. (2006). Breed-specific legislation and the pit bull terrier: are the laws justified? *Journal of Veterinary Behavior*, 1(1), pp.17-22.
- Coppinger, R. & Coppinger, L. (2001) *Dogs: A New Understanding of Canine Origin, Behavior and Evolution*. Chicago, USA: University of Chicago Press.
- Cornelissen, J.M.R. & Hopster, H. (2010). Dog bites in The Netherlands: A study of victims, injuries, circumstances and aggressors to support evaluation of breed specific legislation. *The Veterinary Journal*, 186(3), pp.292-298.
- Duffy, D.L., Yuying, H. & Serpell, J.A. (2008). Breed differences in canine aggression. *Applied Animal Behaviour Science*, 114(3), pp.441-460.
- Fedderson-Peterson, D.U. (2007). Social Behaviour of Dogs and Related Canids. In Jensen, P. (ed.), *Behavioural Biology of Dogs*, (pp. 105-119). Wallingford, UK: CABI International.
- Fogle, B. (1990). *The Dog's Mind*. London, England: Pelham Books.
- Fox, M.W. (1969). The anatomy of aggression and its ritualisation in the Canidae: a development and comparative study. *Behaviour*, 35(3/4), pp. 242-258.
- Freedman, D.G. (1979). *Human Sociobiology: A Holistic Approach*. New York, USA: The Free Press.
- Hart, B.L. (1995). Analysing breed and gender differences in behaviour. In Serpell, J. (ed.), *The Domestic Dog*, (pp. 65-77). Cambridge, UK: Cambridge University Press.
- Helton, W.S. (2009). *Canine Ergonomics: The Science of Working Dogs*. Florida, USA: CRC Press.
- Holmquist, L. & Elixhauser, A. (2010). Emergency Department Visits and Inpatient Stays involved Dog Bites, 2008. *Healthcare Cost and Utilization Project*, Statistic Brief #101, November 2010.
- Haupt, K.A. (2007). Review article: Genetics of Canine Behaviour. *Acta Vet. Brno*, 76, pp.431-444.
- Italian Ministry of Health. (2009). *Ordinanza per la tutela dell'incolumità pubblica dall'aggressione dei cani*. Retrieved from <http://www.salute.gov.it/dettaglio/phPrimoPianoNew.jsp?id=224>
- Jazin, E. (2007). Behaviour Genetics in Canids. In Jensen, P. (ed.), *Behavioural Biology of Dogs*, (pp. 76-90). Wallingford, UK: CABI International.
- Jones, A.C. & Gosling, S.D. (2005). Temperament and personality in dogs (*Canis familiaris*): A review and evaluation of past research. *Applied Animal Behaviour Science*, 95, pp.1-53.
- Kahn, A., Bauche, P. & Lamoureux, J. (2003). Child victims of dog bites treated in emergency departments: a prospective survey. *European Journal of Pediatrics*, 162, pp.254-258.
- Klaassen, B., Buckley, J.R. & Esmail, A. (1996). Does the Dangerous Dogs Act protect against animal attacks: a prospective study of mammalian bites in the Accident and Emergency department. *Injury*, 27(2), pp. 89-91.
- Kottferova, J., Marekova, J., Jakuba, T., Ondrasovic, M. & Ondrasovicova, O. (2008). Aggressive behaviour of dogs and its ethological function. *Folia Veterinaria*, 52(2), 73-574.

- Ledger, R.A., Orihel, J.S., Clarke, N., Murphy, S. & Sedlbauer, M. (2005). Breed specific legislation: Considerations for evaluating its effectiveness and recommendations for alternatives. *Canadian Veterinary Journal*, 36(August), pp.735-743.
- Leshner, A. (1978). *An Introduction to Behavioral Endocrinology*. Oxford, UK: Oxford University Press.
- Lindsay, S.R. (2000). *Handbook of Applied Dog Behaviour and Training, Volume I: Adaptation and Learning*. Iowa, USA: Blackwell Publishing.
- Lindsay, S.R. (2001). *Handbook of Applied Dog Behaviour and Training, Volume II: Etiology and Assessment of Behaviour Problems*. Iowa, USA: Blackwell Publishing.
- Lindell, E.M. (2010). Rethinking the causes of canine aggression. *Veterinary Medicine*, December 2010.
- Lockwood, R. (1995). The ethology and epidemiology of canine aggression. In Serpell, J. (ed.), *The Domestic Dog*, (pp. 131-138). Cambridge, UK: Cambridge University Press.
- Lodge, M & Hood, C. (2002). Pavlovian Policy Responses to Media Feeding Frenzies? Dangerous Dog Regulation in Comparative Perspective. *Journal of Contingencies and Crisis Management*, 10(1), pp. 1-13.
- McCaig, D. (1996). The dogs that go to work, and play, all day - for science. *Smithsonian Magazine*, pp. 126-137.
- McConnell, P.B. (2002). *The Other End of the Leash*. New York, USA: Ballantine Books.
- McFarland, D. (1999). *Animal Behaviour* (3rd ed.). Harlow: Pearson Education Limited.
- Miklosi, A. (2007). *Dog Behaviour, Evolution and Cognition*. Oxford, UK: Oxford University Press.
- Morgan, M. & Palmer, J. (2007). Clinical Review: Dog Bites. *British Medical Journal*, 334, pp.413-417.
- Morris, D. (2008) *Dogs: The Ultimate Dictionary of over 1,000 Dog Breeds*. Vermont, USA: Trafalgar Square Publishing.
- Murray, J.K., Browne, W.J., Roberts, M.A., Whitmarsh, A. & Gruffydd-Jones, R.J. (2010). Number and ownership profiles of cats and dogs in the UK. *Veterinary Record*, 166, pp.163-168.
- NSW Department of Local Government. (2007). *Council reports of dog attacks in NSW July 2004 - June 2005*. Nowra, New South Wales: NSW Department of Local Government.
- O’Heare, J. (2007). *Aggressive Behaviour in Dogs: A Comprehensive Technical Manual for Professionals*. Ottawa, Canada: DogPsych Publishing.
- Overall, K.J. (1997). *Clinical behavioral medicine for small animals*. New York, USA: Mosby.
- Overall, K.J. & Love, M. (2001). Dog bites to humans - demography, epidemiology, injury and risk. *Journal of the American Veterinary Medical Association*, 218(12), pp.1923-1934.
- Ozanne-Smith, J., Ashby, K. & Stathakis, V.Z. (2001). Dog bite and injury prevention - analysis, critical review and research agenda. *Injury Prevention*, 7.4, pp.321-326.
- Parsons, E. (2005). *Click to Calm*. Waltham: Sunshine Books.
- Pasi, B.M. & Carrier, D.R. (2003). Functional trade-offs in the limb muscles of dogs selected for running vs. fighting. *Journal of Evolutionary Biology*, 16, pp.324-332.
- Pickney, L.E. & Kennedy, L.A. (1982). Traumatic Deaths from Dog Attacks in the United States. *Pediatrics*, 69 (2), pp.193-196.
- Raghaven, M., Martens, P.J., Chateau, D. & Burchill, C. (2012). Effectiveness of breed-specific legislation in decreasing the incidence of dog-bite injury hospitalisations in people in the Canadian province of Manitoba. *Injury Prevention*, 18(3), doi:10.1136/injuryprev-2012-040389
- Roll, A. & Unshelm, J. (1997). Aggressive conflicts amongst dogs and factors affecting them. *Applied Animal Behavioural Science*, 52, pp.229-242.
- Sacks, J.J., Kresnow, M. & Houston, B. (1996). Dog bites: how big a problem? *Injury Prevention*, 2, pp.52-54.
- Sacks, J.J., Sinclair, L., Gilchrist, J., Golab, G.C. & Lockwood, R. (2000). Breeds of dogs involved in fatal human attacks in the United States between 1979 and 1998. *Journal of the American Veterinary Medical Association*, 217(6), pp.836-840.

- Saetre, P., Strandberg, E., Sundgren, P.E., Pettersson, U., Jazin, E. & Bergstrom, T.F. (2006). The genetic contribution to canine personality. *Genes, Brain and Behavior*, 5, pp.240-248.
- Schalamon, J., Ainoedhofer, H., Singer, G., Petnehazy, T., Mayr, J., Kiss, K. & Hollwarth, M.E. (2006). Analysis of Dog Bites in Children Who Are Younger Than 17 Years. *Pediatrics*, 117, pp.374-379.
- Schalke, E., Ott, S.A., von Gaertner, A.M., Hackbarth, H., Mittman, A. (2008). Is breed-specific legislation justified? Study of the results of the temperament test of Lower Saxony. *Journal of Veterinary Behavior: Clinical Applications and Research*, 3(3), pp.97-103.
- Scott, J.P. & Fuller, J.L. (1965). *Genetics and the Social Behaviour of the Dog*. Chicago, USA: University of Chicago Press.
- Svartberg, K. (2006). Breed-typical behaviour in dogs - Historical remnants or recent constructs? *Applied Animal Behaviour Science*, 96, pp.293-313.
- Svartberg, K. (2007). Individual Differences in Behaviour - Dog Personality. In Jensen, P. (ed.), *Behavioural Biology of Dogs*, (pp. 182-206). Wallingford, UK: CABI International.
- Thompson, P.G. (1997). The public health impact of dog attacks in a major Australian city. *Medical Journal of Australia*, 167(3), pp.129-132.
- Trut, L. (1999). Early Canid Domestication: The Farm-Fox Experiment: Foxes bred for tamability in a 40-year experiment exhibit remarkable transformations that suggest an interplay between behavioral genetics and development. *American Scientist*, 87(2), pp.160-169.
- Van der Velden, N.A., de Weer, D.T., Brooymans-Schallenberg, J.H.C. & Tielen, A.m. (1976). An abnormal behavioural trait in Bernese Mountain Dogs (Berner Sennenhund). *Tijdschr Diergeneesk*, 101, pp. 403-407.
- Victorian Department of Primary Industries. (2012). *Restricted Breed Dogs*. Retrieved from <http://www.dpi.vic.gov.au/pets/dog-care/restricted-breed-dogs>
- Villalbi, J.R., Cleries, M., Bouis, S., Peracho, V. & Duran, J. (2010). Decline in hospitalisations due to dog bite injuries in Catalonia, 1997-2008. An effect of government regulation? *Injury Prevention*, 16, pp. 408-410.
- Watson, L. (2003). Does breed specific legislation reduce dog aggression on humans and other animals? A review paper. *Urban Animal Management 13th Conference Proceedings*. St Leonards, NSW: Australian Veterinary Association. Retrieved from http://www.ccac.net.au/files/Does_breed_specific_leg_reduce_UAMo3Watson_o.pdf
- Watson, L. (2011, August 25). Breed blame-game: banning Pit Bulls won't work. *The Conversation*. Retrieved from: <http://theconversation.edu.au/breed-blame-game-banning-pit-bulls-wont-work-3036>
- Weiss, H.B., Friedman, D.I. & Jeffrey, H. (1998) Incidence of Dog Bite Injuries Treated in Emergency Departments. *Journal of the American Medical Association*, 279 (1), pp.51-53.
- Wilson, E.O. (1975). *Sociobiology: The new synthesis*. Cambridge, UK: Harvard University Press.
- Wright, J.C. & Nesselroete, M.S. (1987). Classification of Behavior Problems in Dogs: Distributions of Age, Breed, Sex and Reproductive Status. *Applied Animal Behaviour Science*, 19, pp.169-178.
- Wright, J.C. (1996). Canine Aggression: Dog Bites to People. In Voith, V.L. & Borchelt, P.L. (eds.), *Readings in Companion Animal Behavior* (pp.240-246). New Jersey, USA: Veterinary Learning Systems.