The other side of the bond:

Domestic dogs' human-like behaviors

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Abstract

This chapter reviews research on the relationship between pet domestic dogs and children. Dogs are common in human homes with children. Growing literatures exist on how dogs respond to cues given by adult humans and on the characteristics of dogs and the child-dog situation that constitute risk factors in dog bites. There is no literature, however, on particular behaviors produced by children and dogs and how members of each species respond to each other. The chapter argues for a science of child-dog interaction modeled on research currently carried out on child development and on research on dog cognition.

Two hundred years ago Charles Darwin introduced his theory of the origin and mutability of species through natural selection (Darwin, 1859/1968). To help convince his readers that selection of any kind could form new species, or at least shape animals and plants to the point that they could be viewed by "competent judges as the descendants of aboriginally distinct species," (p. 78) Darwin dedicated the whole first chapter of the *Origin of Species* to a consideration of "Variation under Domestication." Many a student has been puzzled by the lengths the great man dedicated to discussion of the breeding of dogs and pigeons. But Darwin's purpose was to argue from a firm basis in something with which his audience was thoroughly familiar. As a Victorian gentleman speaking to Victorian gentlemen, Darwin drew on their shared experience of selecting from among their animals and plants those with the most useful properties as the parents of future generations. Darwin believed that "domestic animals were originally chosen by uncivilised man because they were useful and bred readily under confinement" (1859/1968: p. 180), and went on to argue that what men had wrought, often unconsciously, nature could also achieve. That is to say that there could be natural selection which was analogous to the selection that people carried out on domesticated species.

Although Darwin's theory of Natural Selection has stood the test of time admirably, his opinion that domesticated animals arose through artificial selection – the active selecting of more useful individuals by humans – is, we believe, an error. Dogs are not a product of artificial, but of natural selection. Dogs started adapting to a new niche, the human domicile, that appeared in the Mesolithic. Genetic evidence suggests multiple and ancient origins to dogs over 40,000 years ago (Vila et al., 1997). Archaeological

evidence suggests that an intimate relationship between people and dogs did not arise until around 15,000 years ago (Nobis, 1979).

To this day, artificial selection is a factor to which only a small minority of dogs are exposed. The overwhelming majority of dogs in the third world breed without human intervention (Coppinger & Coppinger, 2001), and even in the United States, New et al. (2004) estimated that fewer than half of all litters born to dogs living in human households were the product of matings controlled by humans.

To point out that dogs are a product of natural rather than artificial selection is not to deny that the ecological niche for the vast majority of dogs is the human domicile. In the United States today, families provide homes to over 70 million pet dogs (American Pet Products Manufacturers Association [APPMA], 2008; American Veterinary Medicine Association [AVMA], 2007). No reliable estimates of the numbers of stray dogs are available. In the contemporary U.S.A. their numbers appear to be very small – and even stray dogs depend on human refuse for their survival (Coppinger & Coppinger, 2001).

Nearly 40% of American homes house a pet dog (APPMA, 2008; AVMA, 2007). Indeed in modern America, more families include a dog than a child (31%: U. S. Census, no date). Dogs are no more common in families with children than those without (41% compared to 40% in the general population: APPMA, 2008). An Australian study found that pets in general were less commonly found in households with young children (birth to four years) but the likelihood of finding pets in a family increased with the age of the children (Shuler, et al., 2008).

The fact that these pets are a voluntary acquisition, as well as copious anecdotal evidence, indicates that dogs provide great pleasure to many people. A recent study

indicates that people with a strong relationship with their dog release more oxytocin when their dog looks at them than people with a weaker relationship to their dog whose dog looks at them less (Nagasawa, Kikusui, Onaka, & Ohta, in press). Oxytocin is a hormone implicated in social affiliative behaviors known to be released during birth and lactation.

Dogs are clearly a great source of pleasure to many children in the developed world. On the other hand, children are also the most likely victims of dog attacks (Gershman et al., 1994). In more than half of dog-caused fatalities in the United States the victims were children (Sacks et al., 1996; Tan, 1997), with five to nine-year-olds being the group at greatest risk (National Center for Injury Prevention and Control, 2008). Although fatalities remain very rare in the United States, the pattern for the approximately five million annual nonfatal dog bites is similar: 42% of all bites were to children under the age of 14 (Center for Disease Control, 2003).

Thus from the point of view of understanding the pleasure that dogs may bring children, and minimizing the harm that dogs can cause them, detailed study of the interaction of dogs and children is of great importance. Unfortunately, however, to our knowledge, there have been no detailed analyses of dog-child interaction. In this chapter we compile what is known about the responsiveness of pet dogs to human cues (studies in which the cues have all been offered by adult humans), and what is known about factors that precipitate dog attacks on children. These two types of study are necessarily at different levels of analysis; for obvious ethical reasons, no experimental study has been performed to look at the actions of children that might trigger dog attacks. The chapter concludes with an analysis of the importance of appropriate socialization of pet dogs if

the pleasure and pedagogic value they can bring to children is to be maximized while the risks are kept to a minimum. The coda is a *plaidoyer* for detailed experimental research on the nature of child-dog interactions: what cues do children present to dogs, how do dogs react to them?

Human-dog interaction.

Research over the last decade has proven pet owners right: Domestic dogs really do have a remarkable sensitivity to human actions and intentions (see Miklósi, 2008; and Udell & Wynne, 2008, for more complete reviews of this literature). In one of the simplest and most widely used tests of dogs' sensitivity to human cuing actions, an experimenter places herself between two containers. These containers are equidistant from the experimenter, usually about two meters apart. The experimenter points to one of the containers while the dog is attending to her from two or three meters back (see Figure 1). Commonly both containers are baited, but only the food in the pointed-to container can be obtained by the dog. Numerous studies, starting with Miklósi, Polgardi, Topál, and Csanyi (1998), have shown that pet domestic dogs living in human homes are highly proficient at finding food by following human pointing gestures under these circumstances. Typically in studies of this type, the experimenter returns to a resting position with all limbs in a natural position close to the midline, before the dog makes its choice. Miklósi et al.'s original (1998) study showed that their dogs were able to use human hand and arm pointing, head nodding, bowing, and head turning to locate the container with accessible food. Subsequent studies have extended the range of human gestures dogs can use to locate food to include many forms of pointing with the arm (Hare & Tomasello, 1999; Miklósi et al., 2005; Miklósi et al. 1998; Soproni, Miklósi,

Topál, & Csanyi, 2001; Soproni, Miklósi, Topál, & Csanyi, 2002; Udell, Giglio & Wynne, 2008), pointing with the leg (Udell et al., 2008), and glancing with the eyes and head (Miklósi et al. 1998; Soproni et al. 2001; Udell et al., 2008). A similar outcome was found in a study in which a trained dog acted as the 'experimenter' to indicate the location of a hidden food item by gazing at it (Hare & Tomasello, 1999).

---Figure 1 About Here.---

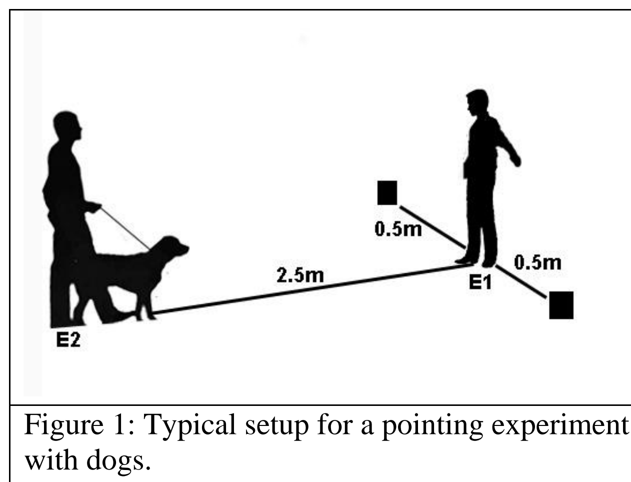

Figure 1: Typical setup for a pointing experiment with dogs.

Although earlier studies suggested that the ability to follow human points was present in all dogs, a more recent study has shown that, though most pet dogs living in human homes are able to follow points, this ability is not present in dogs living at an animal shelter facility, even after pretesting for willingness to eat from the experimenters' hands and lack of fear responses to the experimenters (Udell, Dorey & Wynne, 2008).

As well as responding to human cues, one study has shown that dogs in turn can effectively cue their human caretakers to find a food item or toy that the dog, but not the human, had seen hidden. Miklósi, Polgardi, Topál, and Csanyi (2000) showed dogs the hiding of an item while the dog's owner was out of the room. On the owner's return, the

tethered dog was able to communicate the location of the hidden item to the owner by alternation of its gaze between the hidden location and the owner.

Dogs show sensitivity to the attentional state of humans in other ways. For example, dogs are more likely to take food that they have been forbidden to touch if the experimenter cannot see them than if the experimenter's view of the dog remains unobscured. This was found when the experimenter had left the room, had a barrier between her and the dog, or even if her eyes were closed (Brauer, Call & Tomasello, 2004; Call, Brauer, Kaminski, & Tomasello, 2003).

Gacsi, Miklósi, Varga, Topál, and Csanyi (2004) showed that dogs are sensitive to the body orientation and eye visibility of a human being in another way. They gave dogs the choice of two people from whom to beg for treats. One person had a blindfold over her eyes; the other had the blindfold over her forehead so that her eyes were not covered. In another condition the dogs had to choose between one person looking straight at them and another looking away. The dogs were given food no matter from whom they begged on each trial. In both conditions, the dogs showed a significant preference for the person whose vision was unobscured. Cooper et al. (2003) carried out a similar experiment, offering dogs in different conditions choices between people whose vision was obscured by blindfolds, hands over their eyes, a bucket over the head, or a book in front of their face. In each case, a person whose vision was not obscured, but who held the same occluder near their head, served as the alternative choice. Dogs' performance was above chance in all cases, but the book in front a person's face was a markedly more salient stimulus for the dogs than the other forms of blindfold.

Kaminski, Call, and Fischer (2004) reported the ability of a dog known as Rico to recognize vocal labels for over 200 items. Rico was able to select the correct item from a neighboring room when instructed vocally.

This litany of dogs' successes on tasks requiring the comprehension of cues offered by humans often surprises professional comparative psychologists more than it shocks dog owners. For the comparative psychologist the performance of dogs is remarkable because of the long history of failures to show similar skills in human's closest relatives, the great apes. For example, when chimpanzees were given a choice of two containers, the rewarded container being the one pointed to by a human experimenter, few succeeded in using human cues such as pointing to locate a hidden object unless they were given very extensive training (Call, Hare, & Tomasello, 1998; Call & Tomasello, 1998; Itakura, Agnetta, Hare, & Tomasello, 1999; Povinelli, Reaux, Bierschwale, Allain, & Simon, 1997; Tomasello, Call, & Gluckman, 1997). The success of dogs compared to the difficulties of chimpanzees on related tasks raises interesting questions about the origin and development of these skills in dogs.

The development of human-compatible behaviors in dogs

Over the last decade there has been considerable debate about the origin of human-compatible behavior in the domestic dog. Some researchers have proposed that dogs are born with the skills and cognitive abilities they need to effectively interpret human gestures and interact with humans in beneficial ways throughout their lives (Hare, Brown, Williamson, & Tomasello, 2002; Riedel, Schumann, Kaminski, Call & Tomasello, 2008). Thus the human-canine bond is sometimes presumed to be inevitable

and independent of the rearing history of the dog involved (Hare et al., 2002). There is, however, ample evidence to the contrary.

Domestic dogs, like many other species, require experience with conspecifics to form social bonds, and this socialization must occur within a specific window of time for the dog's social behavior to develop normally (Scott & Fuller, 1965). This is also true of the domestic dog's ability to form bonds with members of other species, including humans. Although some breeds of dog are receptive to socialization with humans up to 16 weeks of age (Coppinger & Coppinger, 2001), a study by Freedman, King, and Elliot (1961) demonstrated that, for some breeds, the seventh week of life marks a turning point for optimal socialization with humans. Using cocker spaniels and beagles, the effects of socialization at two, three, five, seven, nine, or after fourteen weeks was determined by each dog's attraction to the handler, resistance to leash training, and reactivity to aversive stimuli. The investigators found that dogs socialized each day during only their seventh week of life, showed the most stable receptiveness to humans both during their week of socialization and at the end of the 14 week testing period. The full sensitive period of socialization, however, ranged from 2.5 to 13 weeks, and dogs socialized within this window were generally responsive to humans. Dogs that were not socialized by 14 weeks of age became fearful of humans and even an intense retroactive three-month attempt to socialize one of these dogs with humans improved the dog's behavior only slightly (Freedman, King & Elliot, 1961). Scott and Fuller (1965) described puppies socialized too late in their development as "like little wild animals and could be tamed only in the way in which wild animals are usually tamed, by keeping them confined so that so that

they could not run away and feeding them only by hand, so that they were continually forced into close human contact" (p. 105).

The United States, like most first-world nations, has institutions for removing unsocialized dogs from human society. If a dog has not been adequately socialized to humans by fourteen weeks of age, it is most likely to end up at a dog shelter, classified as abandoned or abused. A visit to the non-adoptable section of a local dog shelter will provide ample encounters with dogs that fit Scott and Fuller's description.

An understanding of domestic dogs' social development can also be used to establish desired relationships. For example, those who raise dogs as livestock guards limit contact with humans and conspecifics during a puppy's sensitive period of social development and instead bond the puppy with the species it will one day protect, such as sheep or goats (Lorenz and Coppinger, 1986). By doing so the dog is more likely to stay with the species it has been raised to guard, displaying affiliative behaviors towards this species alone despite the approach of humans or even other dogs.

There is a compounding effect of this initial developmental trajectory. Once a dog has developed a bond with a particular species, it has access to a range of stimuli that it can continue to learn about as long as this contact is maintained. This allows the formation of critical associations between the environment, the behavior of its companions, its own behavior, and various outcomes. For most pet dogs, intense exposure to humans is unavoidable, and since the majority of a pet's reinforcers are provided by humans, there is great benefit to them in learning about human behavior. As mentioned above, dogs are quite sensitive to human actions and readily adjust their behavior in the presence of human stimuli to increase their chances of obtaining desired

items such as food, toys, attention, and so on. In many cases, human action controls dogs' access even to mating opportunities.

Although the domestic dogs' sensitivity to human actions has often been attributed to an evolved human-like social cognition (Hare et al, 2002; Kubinyi & Miklósi, 2007; Miklósi, Topál & Csanyi, 2007), this theory has been brought into doubt by several lines of research. First, Udell, Dorey, and Wynne, (2008) demonstrated that intensely socialized wolves are capable of developing sensitivity to human stimuli, while some domestic dogs fail to respond to such stimuli on identical tests. Second, experience and age do seem to impact performance on human-guided object choice tasks (Dorey, Udell & Wynne, In Prep.; Wynne, Udell & Lord, 2008) and, third, this behavior extinguishes rapidly when reinforcement is withheld (Bentosela, Barrera, Jakovcevic, Elgier & Mustaca, 2008).

These recent findings prompted a novel account of the origin of dogs' sensitivity to human actions – the two stage hypothesis (Udell, Dorey, and Wynne, Submitted) – which stresses the importance of ontogeny in the development of the human-canine bond. This hypothesis does not deny that domestication and other genetic differences have an impact on developmental stages, motor patterns, and even the ease of socialization found in different species, subspecies and breeds. Instead it suggests that all of these features contribute to differences in development and experience that have previously been overlooked by theories that have focused more on the evolution of cognitive faculties.

To increase the probability that a dog will develop sensitivity to human cues to its fullest potential, it is important that two conditions are met: 1. Socialization to humans during a sensitive period of development leading to the acceptance of humans as social

companions. 2. Learning that is not restricted to a particular phase of development to utilize the location and movement of parts of the human body to find or obtain sought-after objects (through Pavlovian and/or operant conditioning). This interaction between species-specific developmental processes and environmental experience not only provides the basis of a strong bond between humans and dogs, but allows for flexibility in their relationship and in the signals an owner might use to communicate with his dog. Because of this, the interactions between humans and dogs are dynamic as well as interactive, giving both human and dog opportunities to develop their unique relationship together. However this knowledge also places the responsibility on every dog owner to provide his dog with the necessary experiences to ensure it is well adjusted to the human environment throughout its life. This means that a dog that will experience children in its lifetime (as surely most pets will) must be socialized to children at an early age and have regular experiences with them throughout its life. It also means that children who will experience dogs in their lifetimes should be taught how to interact with dogs, because each dog is also learning something about children – and adjusting its behavior accordingly – during each interaction. This may include aversive experiences, like repeatedly getting its tail pulled, which could train the dog to avoid children or to take the offensive next time a child approaches. Like any relationship, effective communication and respect are important factors in promoting positive interactions and avoiding unpleasant or even dangerous outcomes.

Dogs' interactions with children.

As noted above, very few studies have investigated the nature of children's interactions with dogs. The few studies that have been done on child-dog interactions

have been correlational and used questionnaires, telephone surveys, dog bite reporting systems such as medical records, and reports collected by veterinarians, to attempt to uncover general benefits or disadvantages to dog ownership. For example, Paul and Serpell (1996) compared mothers' impressions of their eight to twelve-year-old children in the year after obtaining a new pet dog, to impressions of mothers of matched-age children who did not acquire a dog. The results showed few clear health or psychological impacts of dog ownership. At the end of the first month, the dog-owning children had experienced more visits from their friends, and more leisure activities at home with their family, but these changes wore off by the end of the year of observation. At the end of the year, the dog-owning children reported more symptoms of ill health than the children who had not acquired dogs.

Daly and Morton (2006) reported that elementary-school-aged children who owned or preferred both dogs and cats recorded higher scores on a test of empathy than those who owned or preferred only dogs or cats. Children who were highly attached to their pets were also more empathetic than those with lower levels of attachment.

Arambasic, Kuterovac-Jagodic and Vidović, (1999) investigated whether possession of pet dogs or cats acted to buffer elementary-school children's self esteem during the Balkan wars of the 1990s. Contrary to their hypothesis, no beneficial effects of pet ownership on the self-esteem of war-traumatized children were observed.

Some information about dog-child interaction can be gleaned from studies of children as victims of dog bites. With the number of dogs living in human households increasing, it is not surprising that the number of dog bites inflicted on humans is on the rise as well. According to Philips (2008) the number of fatal dog bites almost doubled

between 1990 and 2007. Children are the most common victims of these bites (Reisner, Shofer and Nance, 2007; Sacks, Sinclair, Gilchrist, Golab and Lockwood, 2000), with the perpetrator usually being a dog the child is familiar with (Philips, 2008; Guy, Luescher, Dohoo, Spangler, Miller, Dohoo and Bate, 2001a; Wright, 1990, Wright, 1985). Presently around 2% of the U.S. population is bitten each year (Phillips, 2008). By age 10 the cumulative risk of having been bitten by a dog is about 70% (Sack et al., 2000) with the majority of these bites occurring to the head, face or neck (Weiss, Friedman and Coben, 1998).

Surprisingly, there is no clear consensus in the literature whether the sex of a dog and whether or not it has been sterilized are risk factors for attacks on children. Several papers report more aggression in male dogs than in bitches (Borchelt, 1983; Gershman & Sack, 1994; Guy et al, 2001a; Reisner et al., 2007). Nonetheless, one study contradicts these results and found that in small breeds, females were more aggressive toward humans than males (Guy et al., 2001a) – though other authors have suggested this result may be an artifact of the sampling method used (Luescher & Reisner, 2008; Guy et al., 2001a).

There is also little consensus in the literature on breed of dog as a factor in bites of children. Although several studies have found breed differences in temperament (Scott and Fuller, 1965), handling of novel situations (Plutchik, 1971), working performance (Brenoe, Larsgard, Johannessen, & Uldal, 2002), activity and playfulness (Hart & Miller, 1985), and trainability (Serpell & Hsu, 2005) the literature on breed differences in biting remains very unclear. Several studies of dog bite rates in the United States report that the German Shepherd dogs are the most likely to bite humans (Gershman & Sacks, 1994;

Avner & Baker, 1991; Schalamon, Ainoedhofer, Singer, Petnehazy, Mayr, Kiss & Hollwarth, 2006). Other investigators, however, have found breeds such as Pit bulls (Gandhi, Liebman, Stafford, & Stafford 1999; Sacks et al., 2000) and English Springer Spaniels (Reisner, Erb, & Houpt, 1994; Guy et al, 2001a; Reisner et al, 2005) as having the highest rates of incidents. A recent study by Shuler, Debess, Lapidus and Hedberg, (2008) reported that dogs categorized by the American Kennel Club as herding breeds (e.g. German Shepherd, Boarder Collie, Old English Sheepdog) had the highest rates of biting incidents. Duffy, Hsu and Serpell (2008) suggested that the inconsistency between studies may be due to the context in which the incident occurred. For example, they found that Dachshunds were aggressive in most contexts, but Rottweilers were more aggressive toward strangers rather than their owners.

Some investigators have argued that research should focus on environmental risk factors instead of breed differences (O'Sullivan, Jones, O'Sullivan and Hanlon, 2008; AVMA, 2001). These factors include young and inexperienced owners (Guy et al., 2001a; Miller, Staats, Pertlo & Rada, 1996), dogs not being socialized during the critical period (O'Sullivan et al., 2008), dogs that have been adopted from shelters (Wells & Hepper, 2000), dogs that are constrained by a leash or chain (Thompson, 1997) and the overall health of the dog (Guy et al., 2001a).

Several studies have attempted to identify behaviors in puppies that might predict the likelihood of a dog biting humans when it gets older. Guy et al., (2001b) reported that dogs that were more excitable when they were puppies were more likely to bite their owners as adults. Furthermore, guarding behaviors over both food and toys that might be considered attractive in a puppy could turn dangerous as the dog gets older (Guy et al.,

2001b). Luescher and Reisner (2008) state that in dog bite cases analyzed at two sites, over half of the dogs that were labeled as showing dominance-related aggression started displaying these behaviors in their first year of life.

Interestingly, treating a dog like a family member can increase the risk of dog attacks. Families that allowed their dogs onto furniture, to sleep with them in their beds, or handed them scraps of food from the dining room or kitchen table were at a greater risk of being bitten by their dog (Guy et al., 2001a; O'Sullivan et al, 2008). However, more research needs to be done to identify if this is because of the dog's temperament, the owner's approach, or a combination of the two (Guy et al., 2001a).

Another environmental risk factor is the behavior of the children towards the dogs. Children underestimate the dangers that dogs pose and are more careless and inexperienced than adults when it comes to interacting with dogs (Schalamon et al., 2006). Bites may occur because children cannot discriminate between a dog that wants to play and a dog that is feeling threatened (AVMA, 2001). Bites to children occurred more often when they were in the dog's territory (Reisner et al., 2005). Children could be bitten when they engaged in contact classified as aversive for the dog, such as stepping on the dog (Reisner et al., 2007), pulling its ear (Schalamon et al., 2006), and disturbing the dog while it is eating (Schalamon et al., 2006) or while protecting its possessions (Schalamon et al., 2006). But bites may also occur when the child engages in non-aversive contact but at the wrong time or place, such as petting, hugging and kissing the dog while it is sleeping (Reisner, 2007).

Conclusions

Much is at stake in the study of children's interactions with dogs. As mentioned above, dogs bring much happiness into the 40% of homes with children that include dogs. On the other hand, children are the most common victims of dog bites, with 70% of children bitten by age 10. Schmitt (1998) likened the emotional trauma that a child of five to eleven years experiences as a consequence of dog bite "to an unarmed adult sustaining a bear bite" (p. 1174). Thus it is most troubling that we have been unable to uncover any studies detailing the nature of dog and child interaction. We have been unable to find any studies specifically of the kinds of behaviors children emit in the presence of dogs, or of the behaviors dogs emit in the presence of children. There are several different approaches that could be applied to this problem.

One approach would be to take techniques used in developmental psychology for the study of conspecific interaction to this heterospecific situation. Thus a child or children might be placed in a room with a dog and their interactions observed through a one-way mirror or by video. The dog would be carefully selected to minimize any risk to the children – indeed the dog could even be trained to emit particular behaviors to measure the children's reaction to different scenarios. In effect, the dog would become a canine confederate of the experimenter. Such a technique could be used analytically to gain knowledge of the typical behavior of children towards dogs in different circumstances, and it could be used prophylactically to identify, under safe circumstances, dangerous behaviors of specific children, which could then be rectified.

The methods described above that have been used to study how dogs respond to human cues could be adapted for use with children. A child could be instructed to occupy

the role that is traditionally viewed as that of the ‘experimenter’ – pointing at one of two food containers, for example. The purpose of these studies would be to see how the dogs’ responses differ when a child offers the gesture as compared to the usual scenario where an adult offers cues to the dog. Studies of this type would help uncover how dogs perceive children.

A deeper understanding of how dogs behave towards children, and children around dogs, could inform programs to educate children and dog owners to reduce the risk of dogs to children. This knowledge would increase the chances that a child’s recollections of his or her time with dogs are among the richest rather than the most traumatic. And it holds out promise of reducing the large number of dogs that are rejected from human families each year, many of whom end up destroyed in shelters because their behavior is incompatible with human society (New et al., 2004).

References

American Pet Products Manufacturers Association, (2008). Industry statistics and trends. Retrieved April 24, 2008, from http://www.appma.org.

American Veterinary Medicine Association, (2007). U.S. Pet Ownership & Demographics Sourcebook (2007 Edition). American Veterinary Medicine Association: Schaumburg, IL.

Arambasic, G. K. L., Kuterovac-Jagodic, G. & Vidović, V. V., (1999). Pet ownership and children's self-esteem in the context of war. Anthrozoos, 12, 218-223.

Avner, J. R. and Baker, M.D. (1991). Dog bites in urban children. Pediatrics, 88, 55–57.

Bentosela, M. Barrera, G, Jakovcevic, A. Elgier, A. & Mustaca, A. (2008). Effect of reinforcement, reinforcer omission and extinction on a communicative response in domestic dogs (Canis familiaris). Behavioral Processes, 78, 464-469.

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, 45-61.

Brenoe, U. T., Larsgard, A.G., Johannessen, K. R.& Uldal, S. H. (2002). Estimates of genetic parameters for hunting performance traits in three breeds of gun hunting dogs in Norway. Applied Animal Behaviour Science, 77, 209-215.

Center for Disease Control (2003) Nonfatal Dog Bite-Related Injuries Treated in Hospital Emergency Departments – United States, 2001. Morbidity and Mortality weekly report, 52, 605-610. Available: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5226a1.htm. Accessed 12/20/08.

Cooper, J. J., Ashton, C., Bishop, S., West, R., Mills, D.S., and Young, R.J. (2003). Clever hounds: social cognition in the domestic dog (Canis familiaris). Applied Animal Behavior Science, 81, 229-244.

Coppinger, R. & Coppinger, L. (2001) Dogs: a startling new understanding of canine origin, behavior and evolution. Chicago, IL: Chicago University Press.

Daly, B. & Morton, L.L. (2006). An investigation of human-animal interactions and empathy as related to pet preference, ownership, attachment, and attitudes in children. Anthrozoos, 19, 113-127.

Darwin, C. (1859) On the Origin of Species by Means of Natural Selection (John Murray, London).

Dorey, N. R., Udell, M. A. R., Wynne, C. D. L. (in prep.). Effect of Ontogeny: When do puppies start to understand human points?

Duffy, D. L., Hsu, Y. and Serpell, J. A. (2008). Breed differences in canine aggression. Applied Animal Behaviour Science, 114, 441-460.

Freedman, D. G., King, J. A., Elliot, O. (1961). Critical period in the social development of dogs. Science, 133, 1016-1017.

Gandhi, R. R, Liebman, M. A., Stafford, B. L., Stafford, P. W. (1999). Dog bite injuries in children: a preliminary survey. American Surgeon, 65, 863–864

Gershman, K. A. and Sacks, J. J. (1994). Which dogs bite? A case-control study of risk factors. Pediatrics, 93, 913-924.

Guy, N.C., Luescher, U. A., Dohoo, S. E., Spangler, E., Miller, J. B., Dohoo, I. R. and Bate, L. A. (2001a). Risk factors for dog bites to owners in a general veterinary caseload. Applied Animal Behaviour Science, 74, 29-42.

Guy, N.C., Luescher, U. A., Dohoo, S. E., Spangler, E., Miller, J. B., Dohoo, I. R., Bate, L. A., (2001b). Demographic and aggressive characteristics of dogs in a general veterinary caseload. Applied Animal Behaviour Science, 74, 15–28.

Hare, B., Brown, M., Williamson, C., Tomasello, M. (2002) The domestication of the social cognition in dogs. Science, 298, 1634.

Hart, B. L. and Miller, M. F. (1985). Behavioral profiles of dog breeds. Journal of the American Veterinary Medical Association, 186, 1175-1180.

Kubinyi, E. V. Z. & Miklósi, A. (2007). Comparative Social Cognition: From wolf and dog to humans. Comparative Cognition & Behavior Reviews, 2, 26-46.

Lorenz, J. R. & Coppinger, L. (1986) Raising and training a livestock-guarding dog. Oregon State University Extension Service: Extension Circular, 1238, 1-8.

Luescher, A. U. and Reisner, I. R. (2008). Canine aggression toward familiar people: A new look at an old problem. Veterinary Clinics Small Animal Practice, 38, 1107-1130.

Miklósi, Á., Polgárdi, R., Topál, J., Csányi, V. (1998). Use of experimenter-given cues in dogs. Animal Cognition, 1, 113-121.

Miklosi, A., Topal, J., Csanyi, V. (2007). Big thoughts in small brains? Dogs as a model for understanding human social cognition. Neuroreport, 18, 467-471.

Miller, D., Staats, S.R., Pertlo, C., and Rada, K. (1996). Factors associated with the decision to surrender a pet to an animal shelter. Journal of American Veterinary Medicine Association, 209, 738-742.

Nagasawa, M., Kikusui, T., Onaka, T., & Ohta, M. (In press) Dog's gaze at its owner increases owner's urinary oxytocin during social interaction. Hormones and Behavior.

New, J. C., Kelch, W. J., Hutchison, J. M., Salmo, M. D., King, M., Scarlett, J. M. &

Nobis, G. (1979) Der älteste Haushunde lebte vor 14000 Jahren. [The oldest domestic dog lived 14,000 years ago] Umschau, 79, 610.

O'Sullivan, E. N., Jones, B. R., O'Sullivan, K. and Hanlon, A. J. (2008). The management and behavioural history of 100 dogs reported for biting a person. Applied Animal Behaviour Science, 114, 149-158.

Paul, E. S. and Serpell, J. A. (1996). Obtaining a new pet dog: Effects on middle childhood children and their families. Applied Animal Behaviour Science, 47, 17-29

Philips, K. M. (2008). Dog bite statistics. Retrieved January 13, 2008 from www.dogbitelaw.com

Plutchik, R. (1971). Individual and breed differences in approach and withdrawal in dogs. Behaviour, 40, 301-311.

Reisner, I. R., Erb, H., Houpt, K., (1994). Risk factors for behavior-related euthanasia among dominant-aggressive dogs 110 cases (1989–1992). Journal of American Veterinary Medicine Association, 205, 855–863.

Reisner, I. R., Houpt, K. A. & Shofer, F. S. (2005). National survey of owner-directed aggression in English Springer Spaniels. Journal of the American Veterinary Medicine Association, 227, 1594–1603.

Reisner, I. R., Shofer, F. S. & Nance, M. L. (2007). Behavioral assessment of child-directed canine aggression. Injury Prevention, 13, 348-351.

Riedel, J., Schumann, K., Kaminski, J., Call, J. & Tomasello, M. (2008) The early ontogeny of human-dog communication. Animal Behaviour, 75, 1003-1014.

Sacks, J. J. Sinclair, L., Gilchrist, J., Golab, G. C. and 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, 836-840.

Schalamon, J., Ainoedhofer, H. Singer G., Petnehazy, T., Mayr, J., Kiss, K. and Hollwarth, M.E. (2006). Analysis of dog bites in children who are younger than 17 years. Pediatrics, 117, 374-379.

Scott, J. P. & Fuller, J. L. (1965). Genetics and the social behavior of the dog. Chicago, IL: University of Chicago Press.

Serpell, J. A. and Hsu, Y. (2005). Effects of breed, sex, and neuter status on trainability in dogs. Anthrozoos, 18, 196-207.

Shuler, C. M., Debess, E. E., Lapidus, J. A. and Hedberg, K. (2008). Canine and human factors related to dog bite injuries Journal of the American Veterinary Medical Association, 232, 542-546.

Thompson, P. G. (1997). The public health impact of dog attacks in a major Australian city. Medical Journal of Australia, 167, 129-132.

Udell, M. A. R., Dorey, N. R. & Wynne, C. D. L. (2008). Wolves outperform dogs in following human social cues. Animal Behaviour, 76, 1767-1773.

Udell, M. A. R., Dorey, N. R. & Wynne, C. D. L. What did domestication do to dogs? A new account of dogs' sensitivity to human actions. Submitted.

U.S. Census (no date) Table: S1101. Households and Families. Dataset: 2006 American Community Survey. http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2006_EST_G00_S1101&-ds_name=ACS_2006_EST_G00_&-_lang=en&-redoLog=false&-format=&-CONTEXT=st

Vila, C., Savolainen, P., Maldonado, J., Amorim, I., Rice, J., Honeycutt, R., et al. (1997). Multiple and ancient origins of the domestic drugs. Science, 276, 1687-1689.

Wells, D. L. and Hepper, P. G. (2000). Prevalence of behaviour problems reported by owners of dogs purchased from an animal rescue centre. Applied Animal Behavior Science, 69, 55–65.

Weiss, H. B., Friedman, D. I., Coben, J. H. (1998). Incidence of dog bite injuries treated in emergency departments. Journal of the American Medical Association, 279, 51-53.

Wright, J.C. (1985). Severe attacks by dogs: Characteristics of the dogs, the victims, and the attack settings. Public Health Reports, 100, 55-61.

Wright, J.C. (1990). Reported dog bites: are owned and stay dogs different? Anthrozoos, 4, 111-119.

Wynne, C. D. L., Udell, M. A. R., Lord, K. A. (2008). Ontogeny's impacts on human–dog communication. Animal Behaviour, 76, e1-e4.